FIGURES

INDUSTRI-PLEX SITE

Woburn, Massachusetts

September 1986

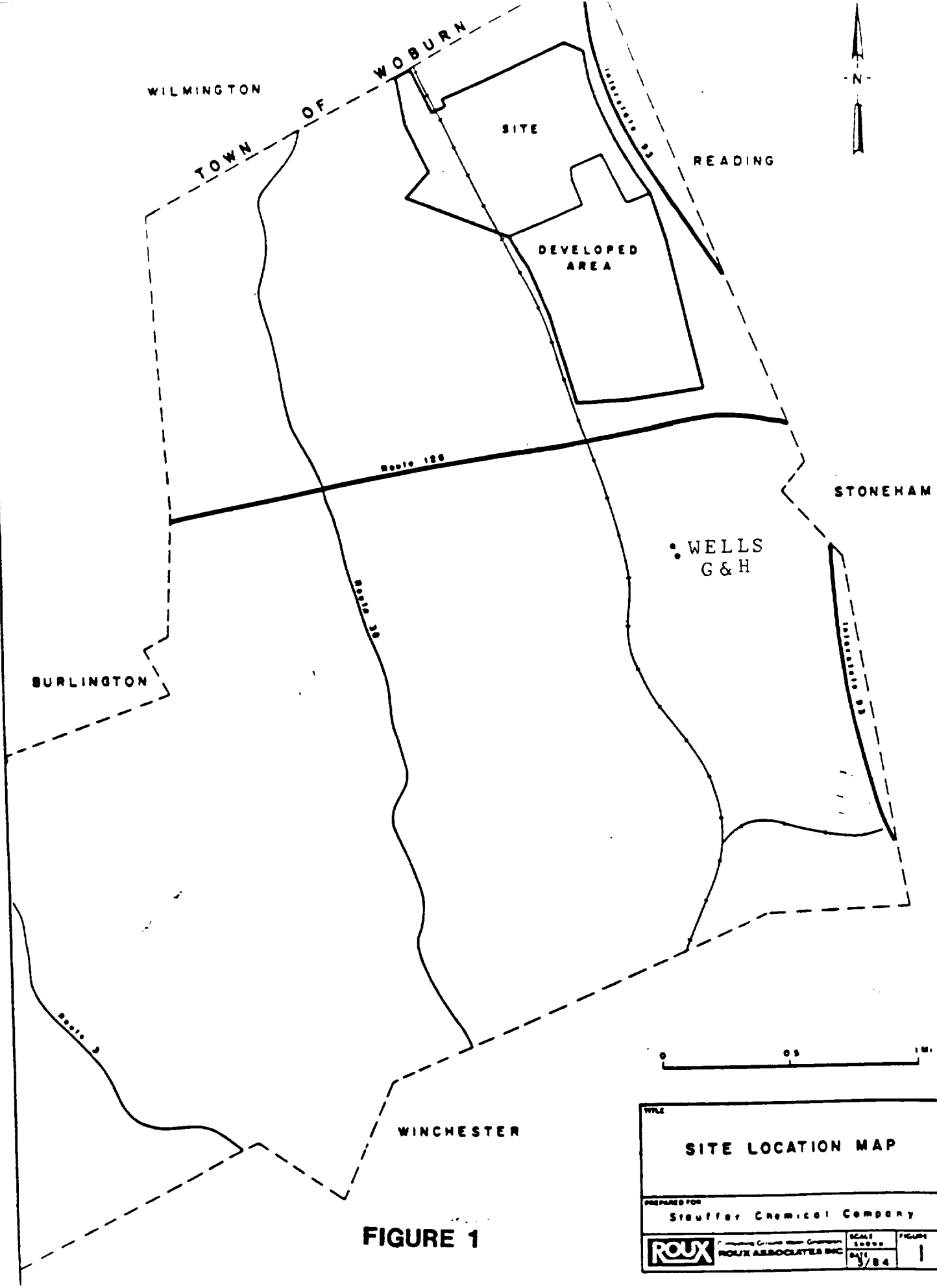
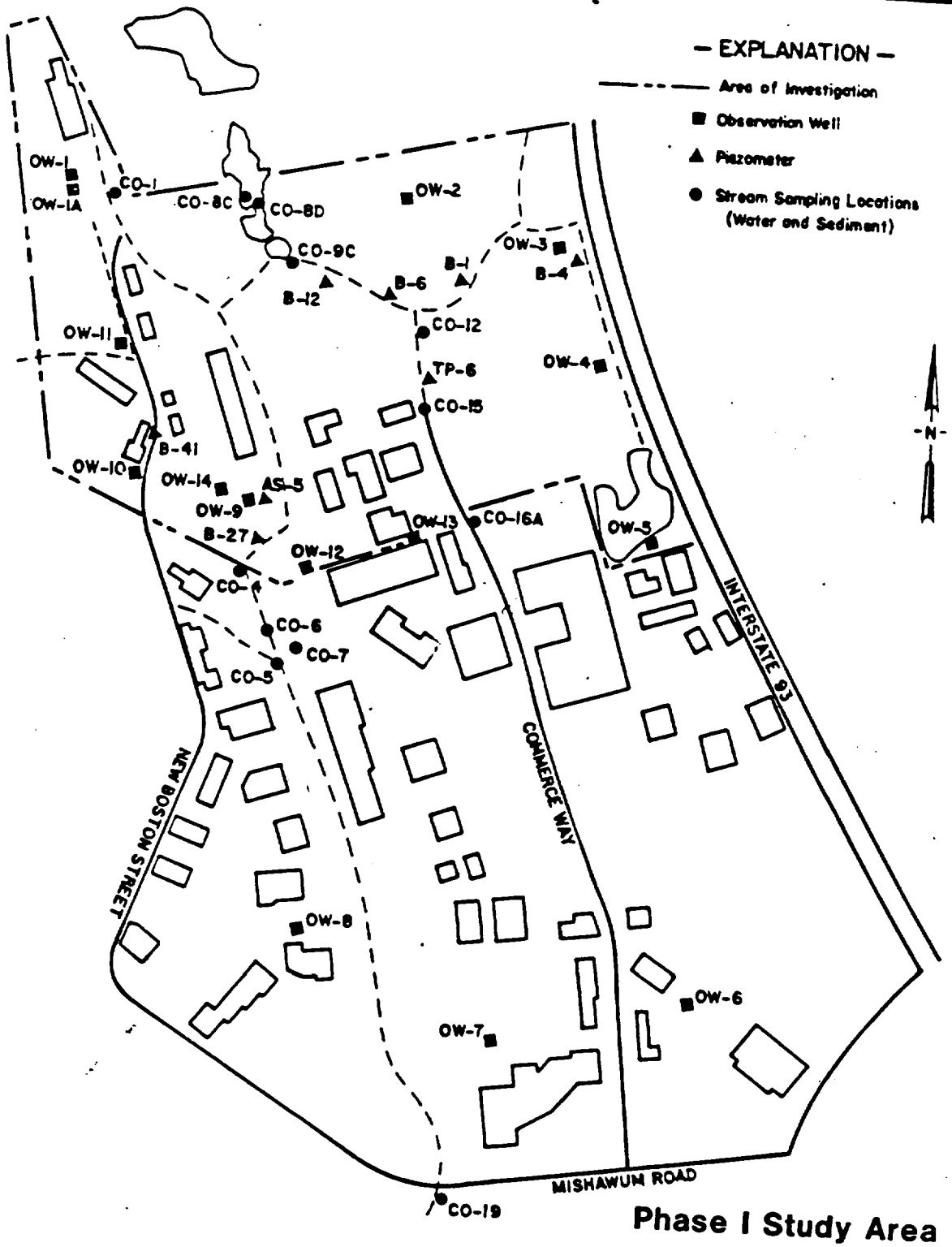

WILMINGTON
TOWN OF WOBURN
SITE
READING
DEVELOPED AREA
N
Route 128
STONEHAM
WELLS G&H
Route 38
BURLINGTON
Route 3
WINCHESTER
0
0.5
1 MI.
TITLE
SITE LOCATION MAP
PREPARED FOR
Stauffer Chemical Company
ROUX
ROUX ASSOCIATES INC
SCALE
DATE
3/84
FIGURE
1

FIGURE 1



Phase I Study Area

FIGURE 2

TITLE

OBSERVATION WELL LOCATION MAP

(With Stream Sampling Points And Piezometers)

PREPARED FOR

Stauffer Chemical Company

ROUX Consulting Ground-Water Geologists
ROUX ASSOCIATES INC

SCALE 1" = 823'

FIGURE

DATE Feb 1983

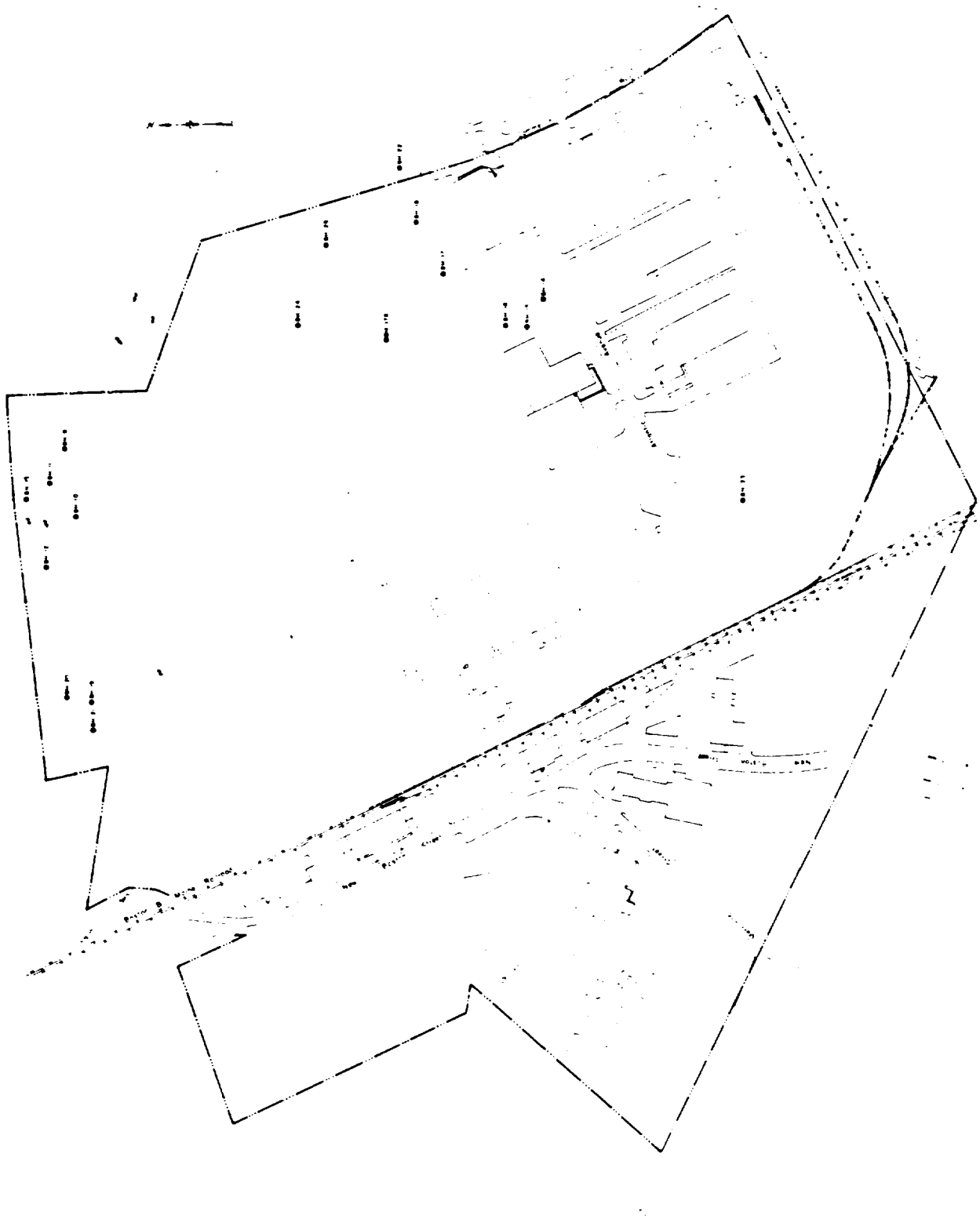
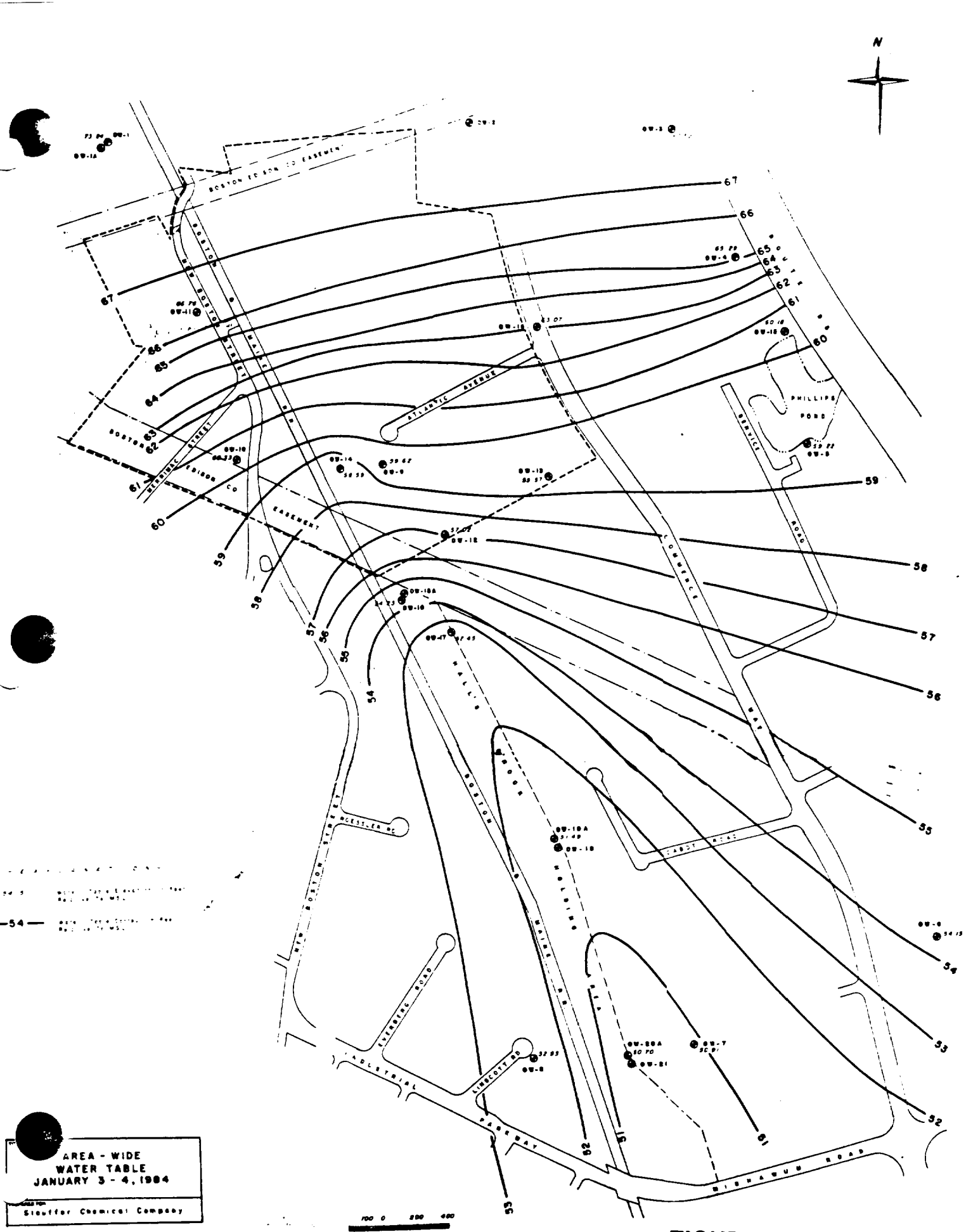


FIGURE 3 **Phase II Study Area**


N
AREA - WIDE
WATER TABLE
JANUARY 3 - 4, 1984
Stauffer Chemical Company
Monitoring Well Location
FIGURE 4

>100 PPM CR, PB OR AS IN SOIL

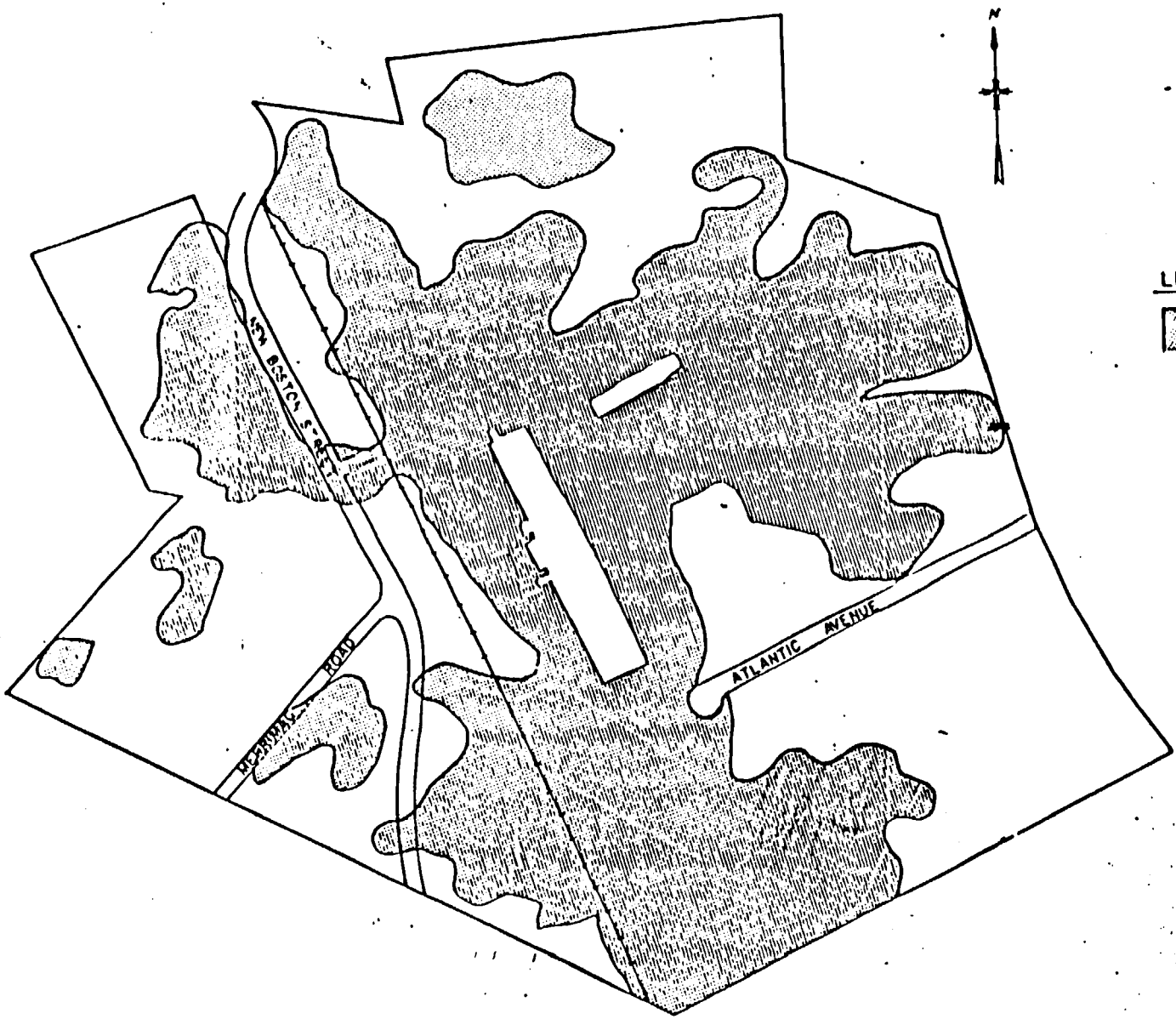


FIGURE 5

MALCOLM PIRNIE

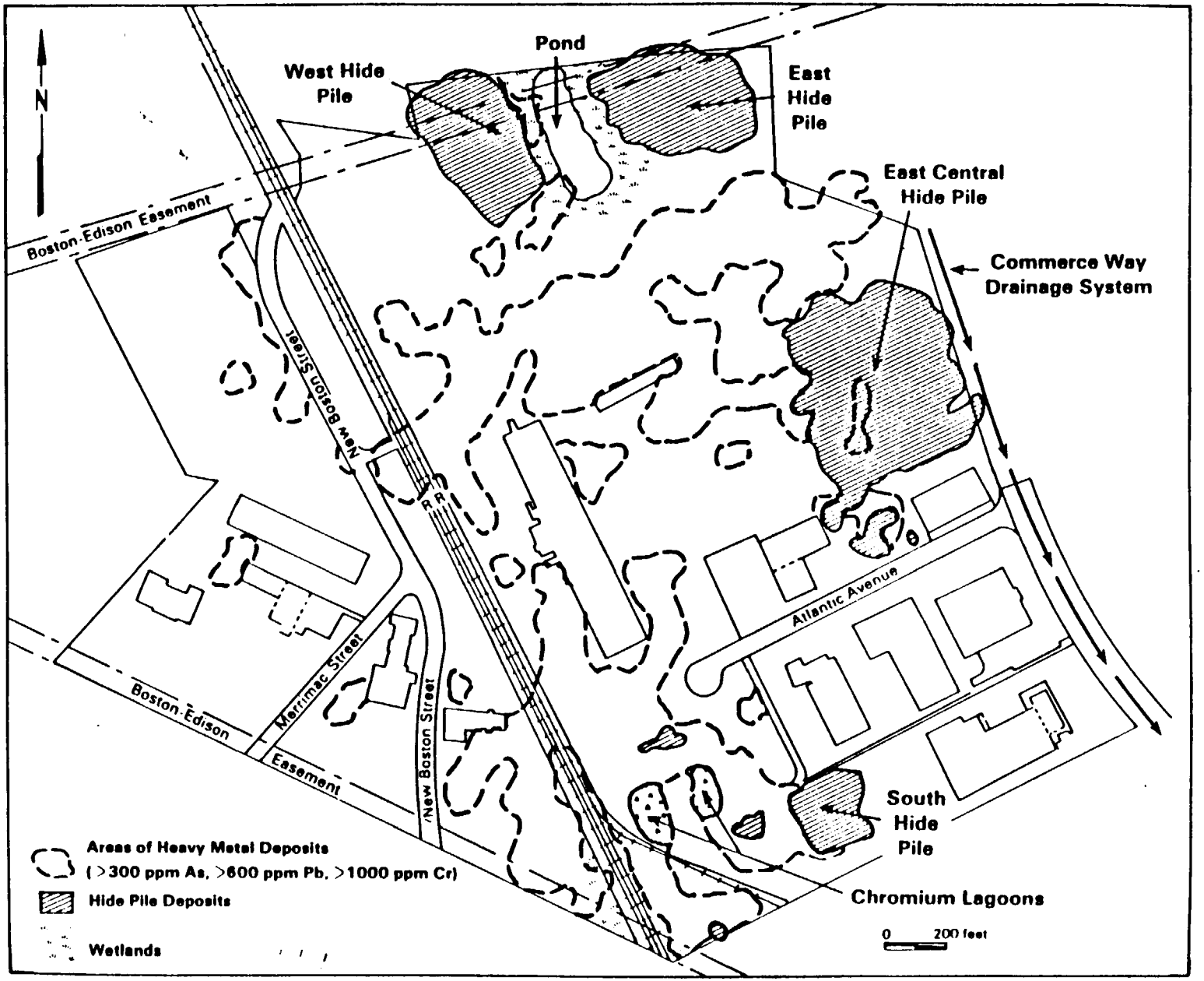

N
Pond
West Hide Pile
East Hide Pile
East Central Hide Pile
Commerce Way Drainage System
Boston Edison Easement
New Boston Street
R R
Atlantic Avenue
Merrimac Street
Boston Edison Easement
New Boston Street
South Hide Pile
Chromium Lagoons
0 200 feet
Areas of Heavy Metal Deposits
(>300 ppm As, >600 ppm Pb, >1000 ppm Cr)
Hide Pile Deposits
Wetlands

FIGURE 6

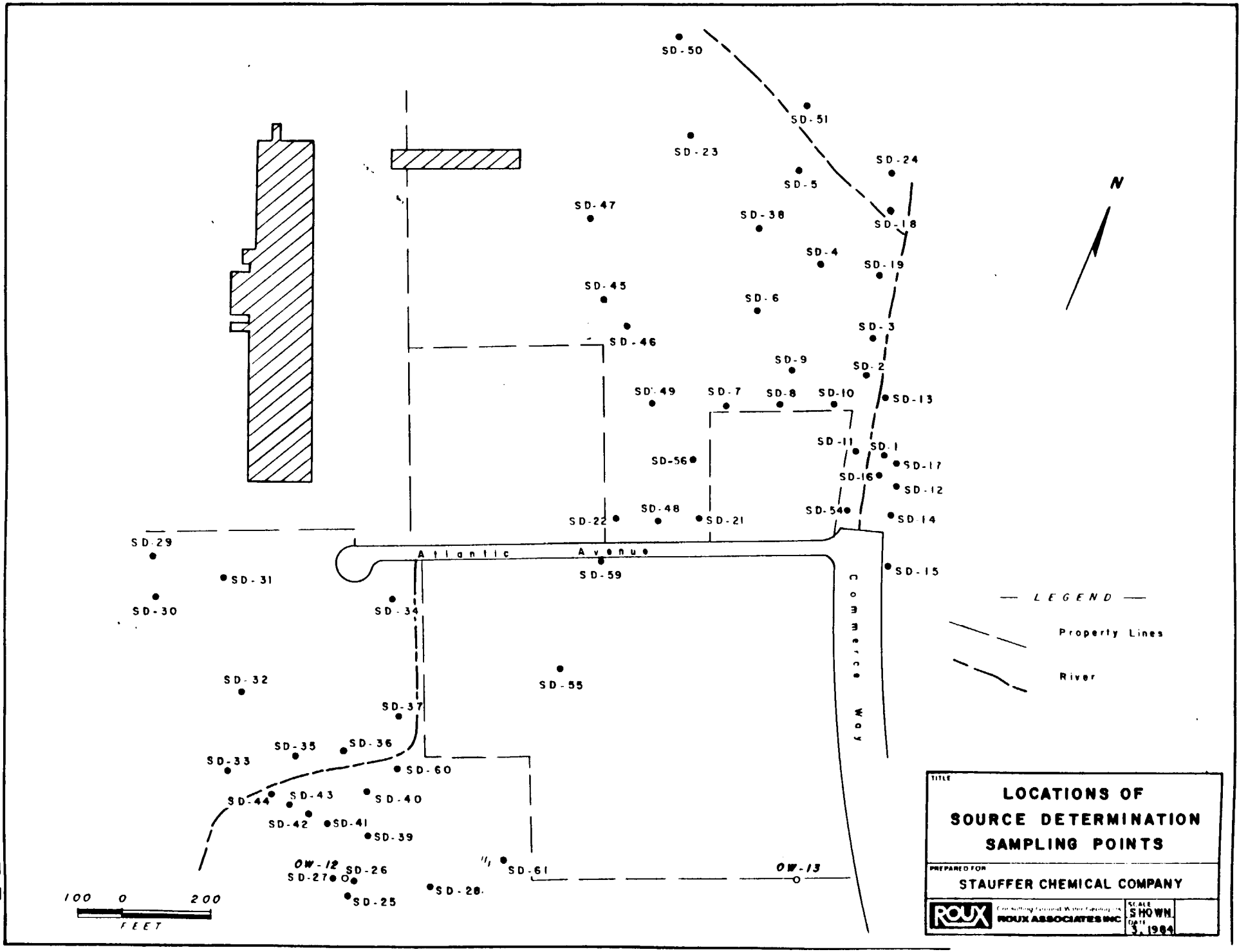

SD-50
SD-51
SD-23
SD-24
SD-5
SD-47
SD-38
SD-18
SD-4
SD-19
SD-45
SD-6
SD-3
SD-46
SD-9
SD-2
SD-49
SD-7
SD-8
SD-10
SD-13
SD-11
SD-1
SD-56
SD-17
SD-16
SD-12
SD-48
SD-54
SD-22
SD-21
SD-14
SD-29
Atlantic Avenue
SD-59
SD-15
SD-31
SD-30
SD-34
Causeway
SD-55
SD-32
SD-37
SD-35
SD-36
SD-33
SD-60
SD-44
SD-43
SD-40
SD-42
SD-41
SD-39
OW-12
SD-26
SD-27
SD-61
OW-13
SD-28
SD-25
100 0 200
FEET
N
LEGEND
Property Lines
River
TITLE
LOCATIONS OF
SOURCE DETERMINATION
SAMPLING POINTS
PREPARED FOR
STAUFFER CHEMICAL COMPANY
ROUX
ROUX ASSOCIATES INC
SCALE
SHOWN
DATE
5, 1984

FIGURE 7

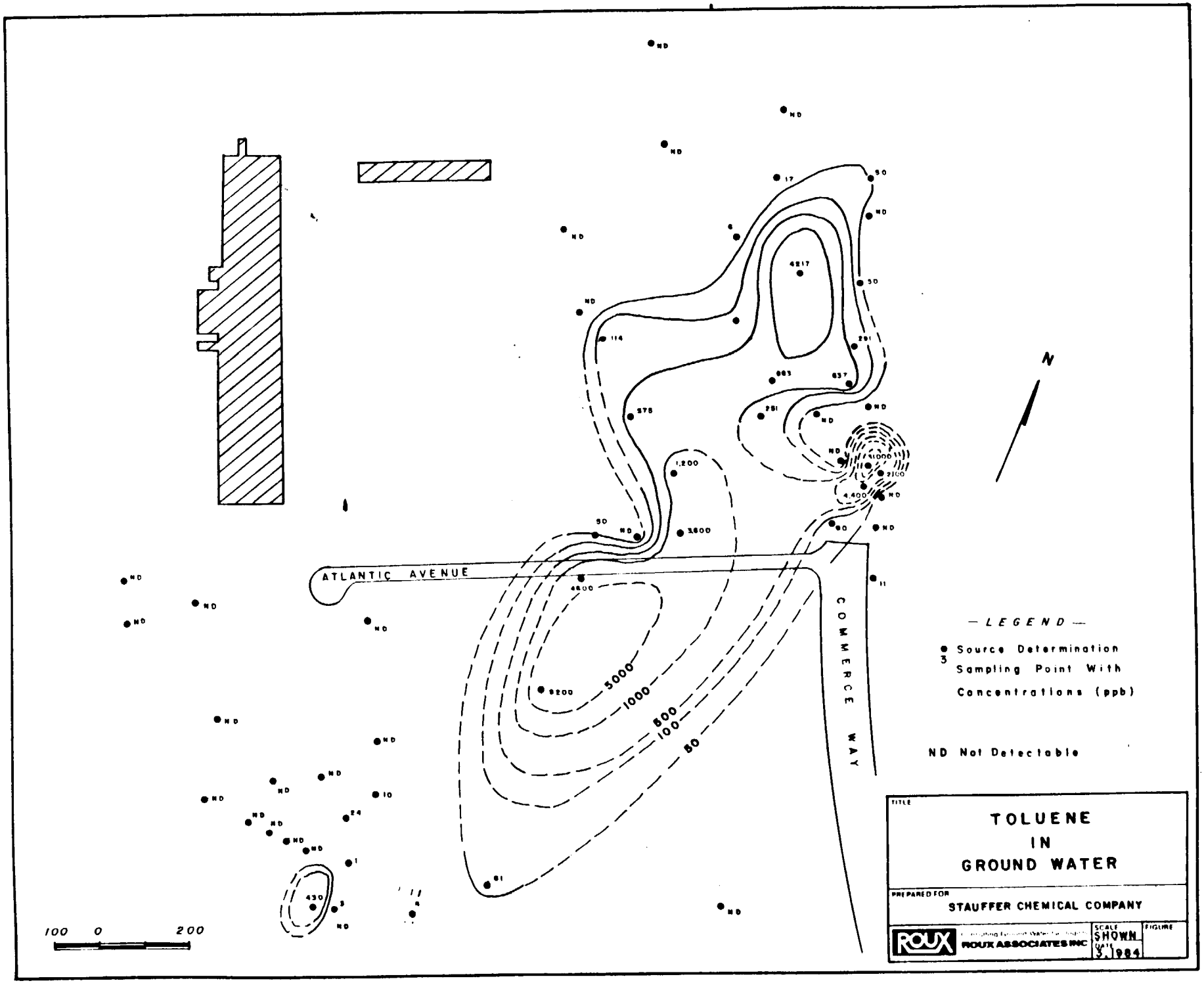

ATLANTIC AVENUE
COMMERCE WAY
N
— LEGEND —
Source Determination
3 Sampling Point With
Concentrations (ppb)
ND Not Detectable
5000
1000
500
100
50
100 0 200
TITLE
TOLUENE
IN
GROUND WATER
PREPARED FOR
STAUFFER CHEMICAL COMPANY
ROUX ASSOCIATES INC
SCALE SHOWN
DATE 5, 1984
FIGURE

FIGURE 8

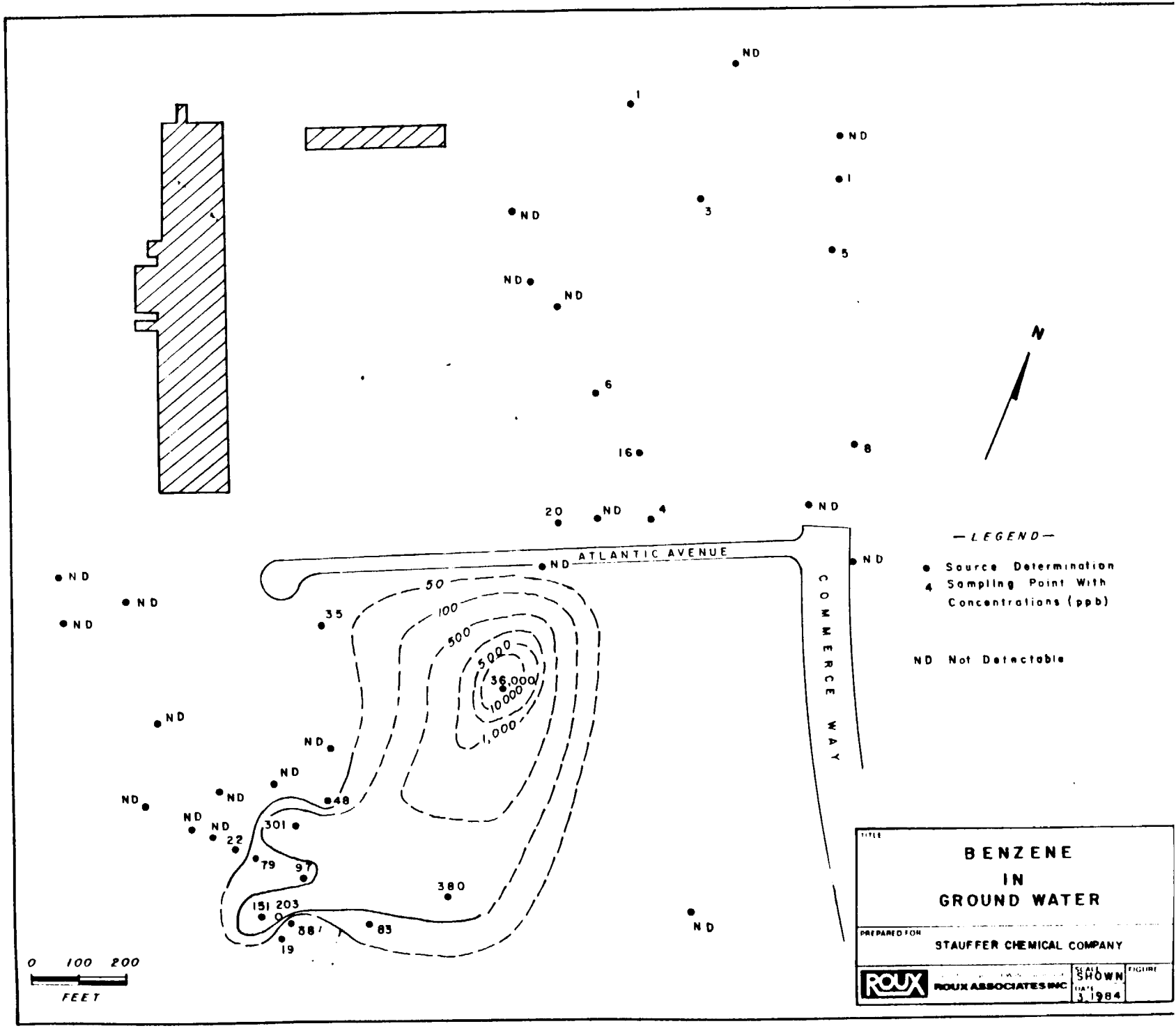

ND
1
ND
1
3
ND
5
ND
ND
6
16
8
20
ND
4
ND
ATLANTIC AVENUE
ND
COMMERCE WAY
ND
ND
ND
35
50
100
500
5000
36,000
10000
1,000
ND
ND
ND
ND
ND
ND
ND
48
301
ND
22
79
97
380
151
203
0
88
83
19
ND
N
— LEGEND —
Source Determination
4 Sampling Point With Concentrations (ppb)
ND Not Detectable
0 100 200
FEET
BENZENE
IN
GROUND WATER
PREPARED FOR
STAUFFER CHEMICAL COMPANY
ROUX
ROUX ASSOCIATES INC
SEE SHOWN
DATE 3 1984
FIGURE

FIGURE 9

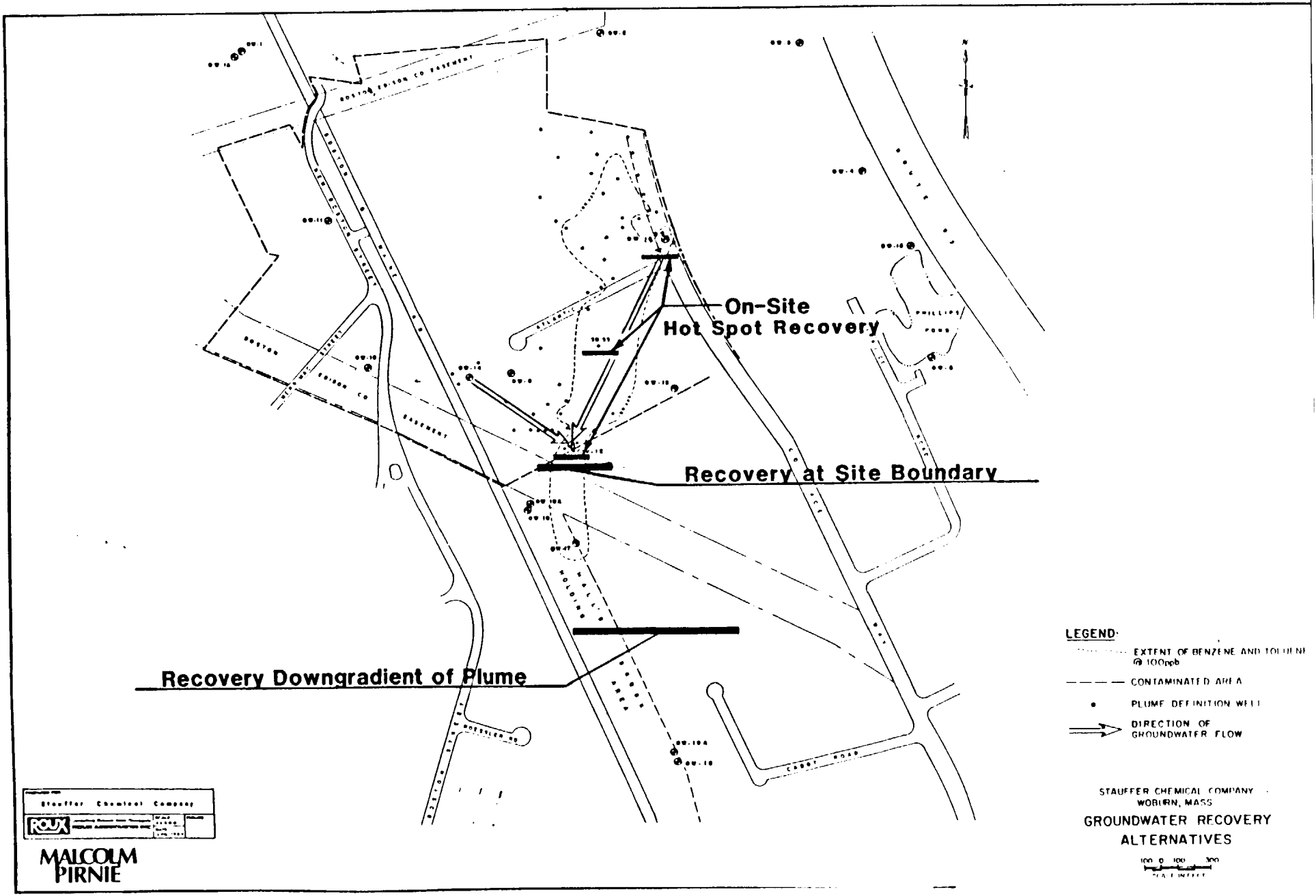

On-Site
Hot Spot Recovery
Recovery at Site Boundary
Recovery Downgradient of Plume
LEGEND:
EXTENT OF BENZENE AND TOLUENE @ 100ppb
CONTAMINATED AREA
PLUME DEFINITION WELL
DIRECTION OF GROUNDWATER FLOW
STAUFFER CHEMICAL COMPANY
WOBURN, MASS
GROUNDWATER RECOVERY ALTERNATIVES
Stauffer Chemical Company
ROUX
MALCOLM PIRNIE

FIGURE 10

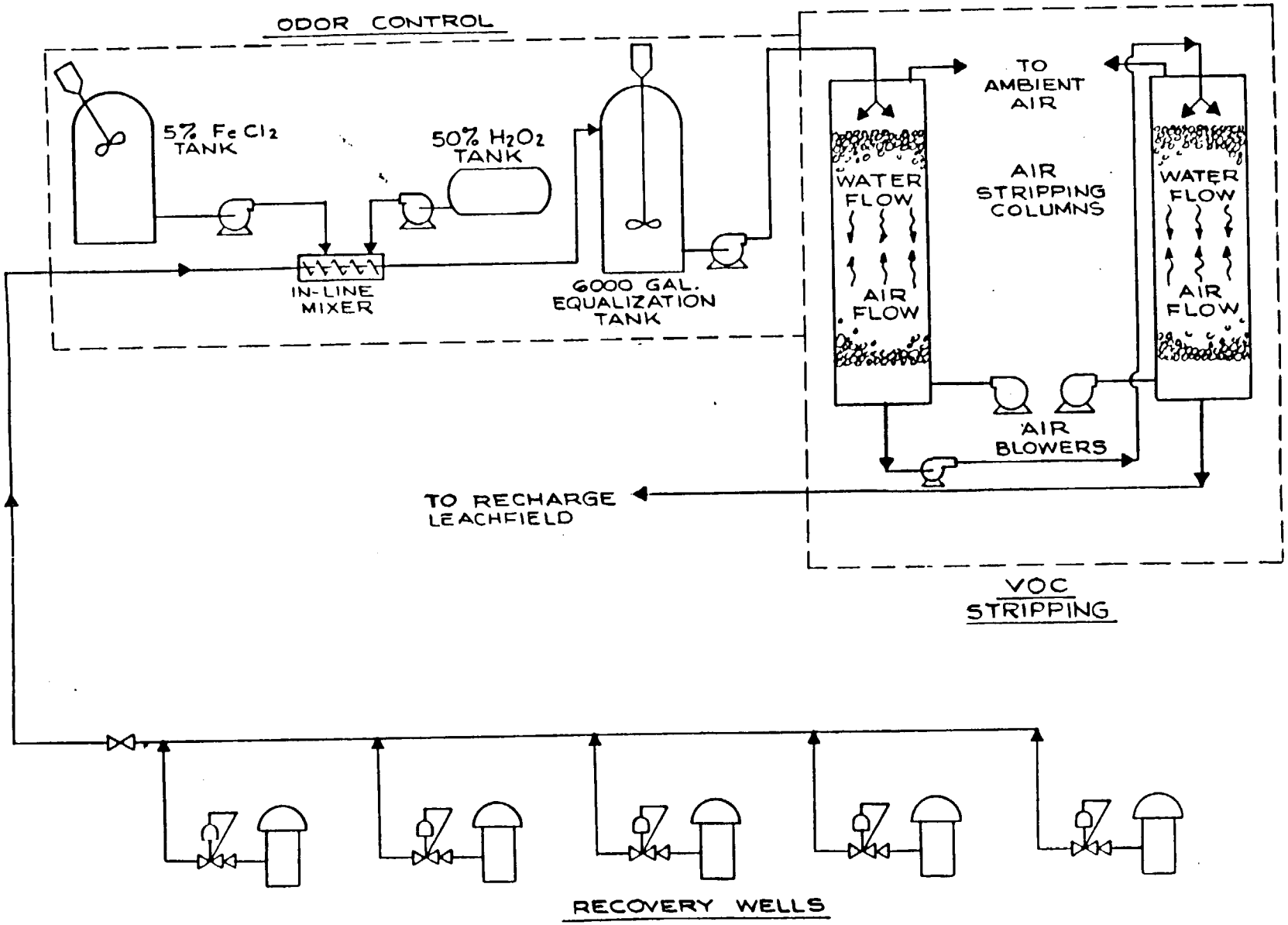


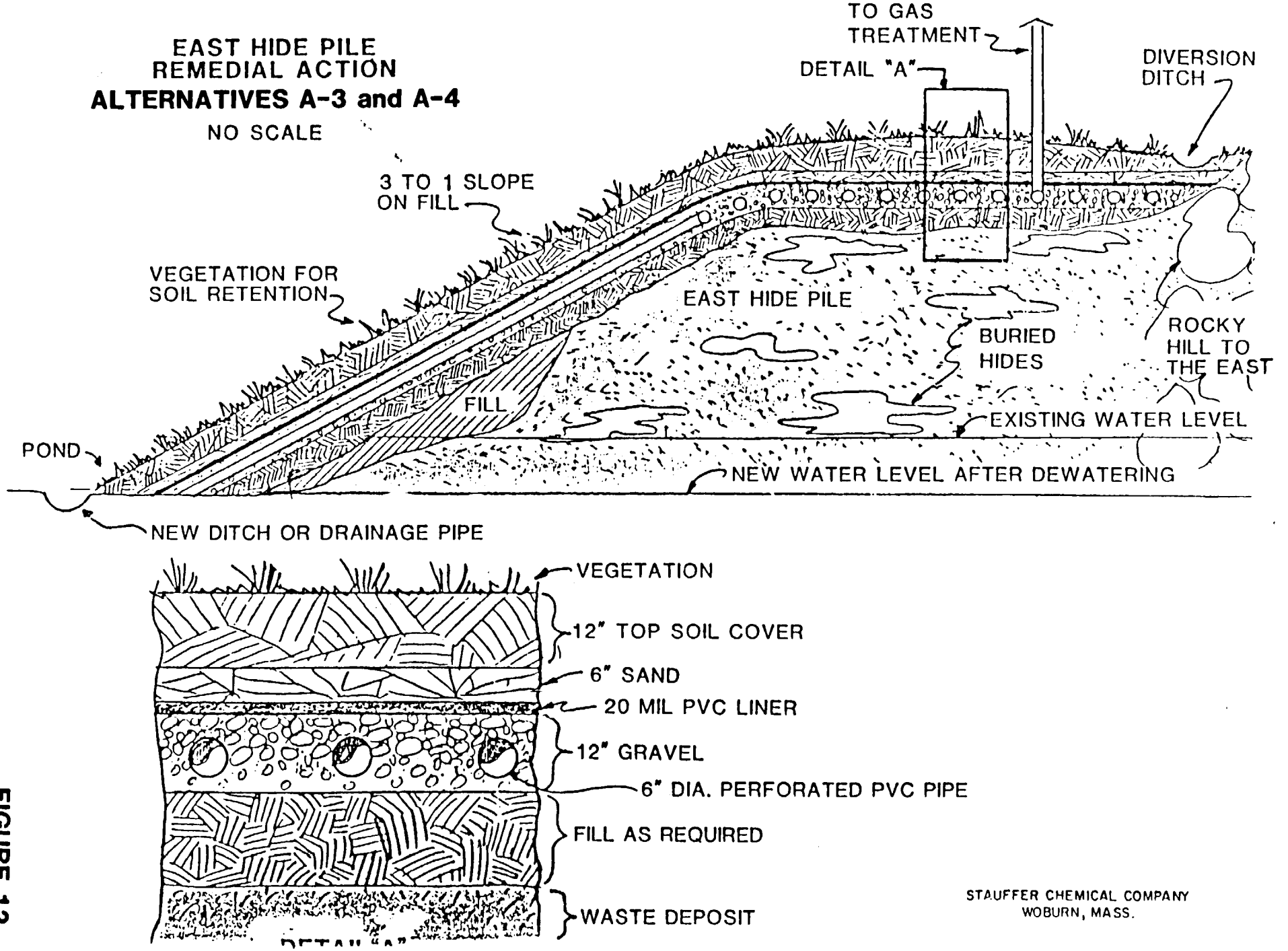
FIGURE 11

STAUFFER CHEMICAL COMPANY
WOBURN, MASS.

GROUND WATER TREATMENT
FLOW SCHEMATIC FOR **ALTERNATIVE GW-**
(HOT SPOT RECOVERY)

EAST HIDE PILE REMEDIAL ACTION
ALTERNATIVES A-3 and A-4

NO SCALE



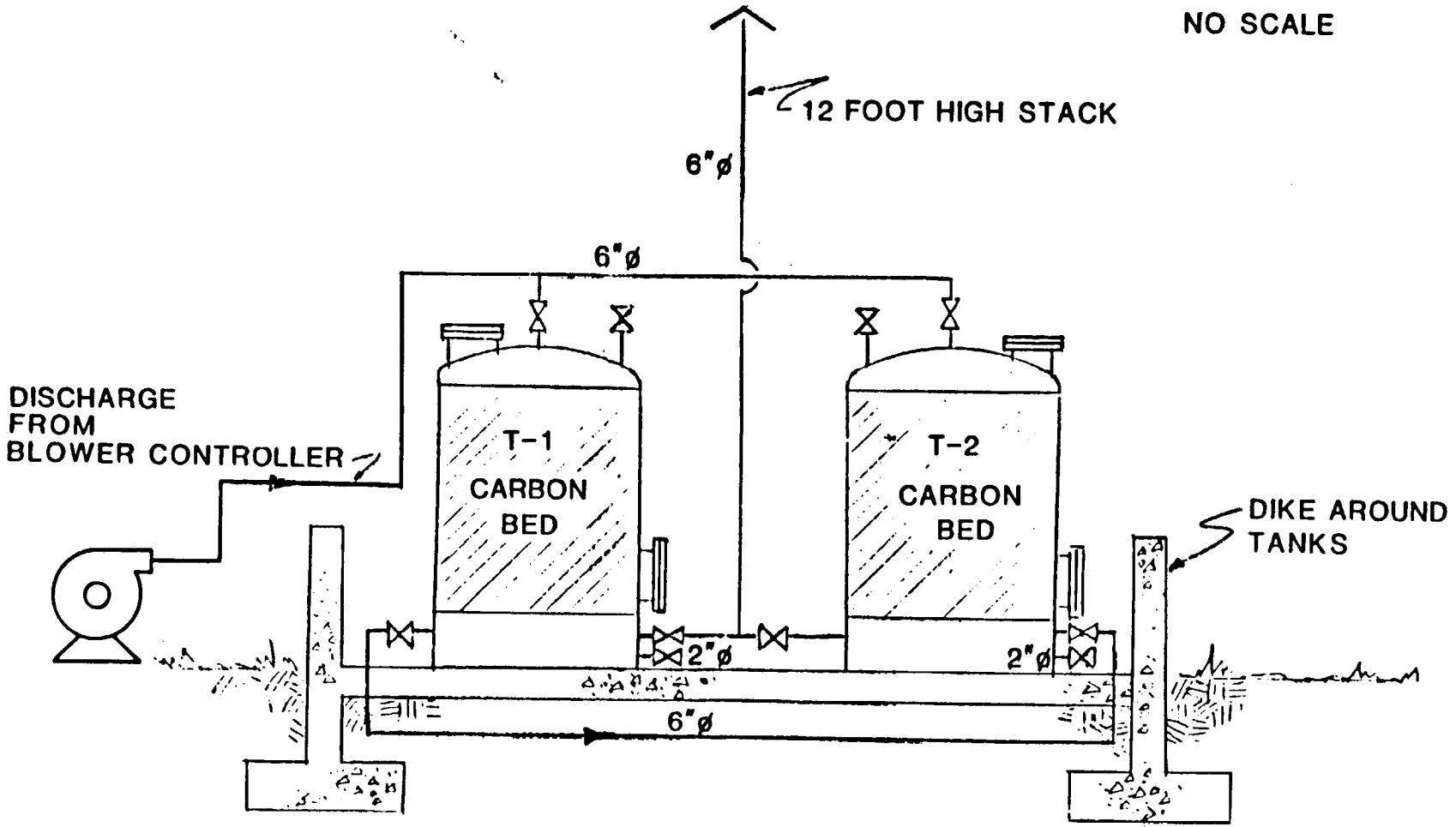
STAUFFER CHEMICAL COMPANY
WOBURN, MASS.

FIGURE 12

ALTERNATIVE A-3

(CARBON ADSORPTION)

NO SCALE



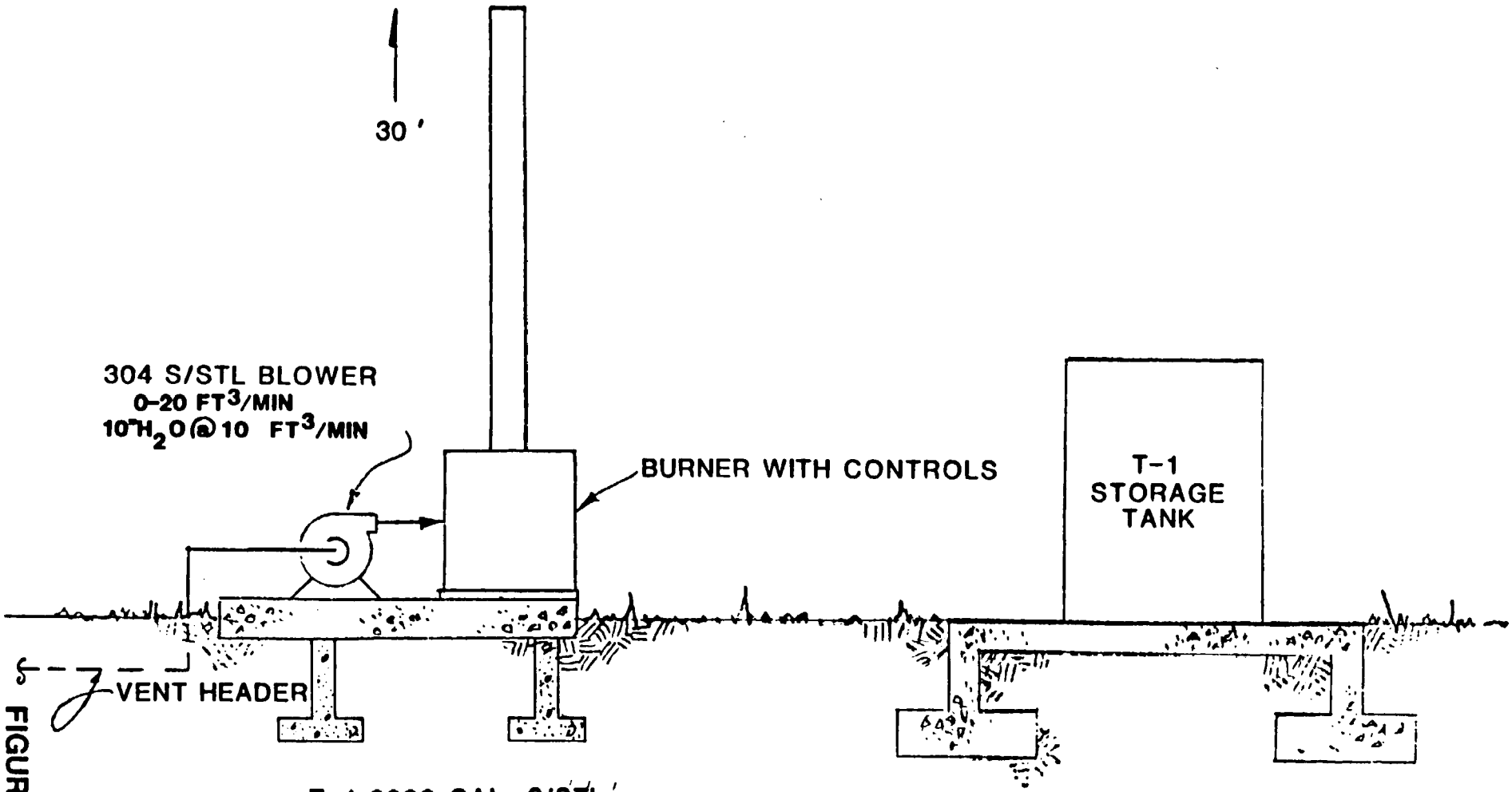
T-1 & T-2 8' DIA. x 6' HIGH 316 S/STL. WITH TOP MANHOLE, SIDE MANHOLE, FLUSH BOTTOM DRAIN, WITH INTERNAL SCREEN TO SUPPORT 6000 LBS. CALGON TYPE IVP CARBON BED

FIGURE 13

STAUFFER CHEMICAL COMPANY
WOBURN, MASS.

ALTERNATIVE A-4

(THERMAL OXIDATION)
NO SCALE



T-1 3000 GAL. C/STL
PROPANE STORAGE TANK

STAUFFER CHEMICAL COMPANY
WOBURN, MASS.

FIGURE 14

TABLES

INDUSTRI-PLEX SITE

Woburn, Massachusetts

September 1986

Summary of Phase II Soil Heavy Metal Analysis

Element	1065 Samples Analyzed				Distribution of Samples >100 PPM				
	0-100 PPM	>100 PPM	>500 PPM	>1000 PPM	25 Perc. Concent.	50 Perc. Concent.	75% Perc. Concent.	Maximum	Average
Arsenic	705	360	127	56	188	344	700	30800	809
Chromium	744	321	283	117	195	533	1890	80600	2300
Copper	625	440	202	106	198	418	940	23300	1042
Lead	517	548	346	249	330	819	2380	54400	2426
Mercury	1058	7	2	1	-	-	-	1900	-
Zinc	437	628	310	191	214	496	1350	126600	2072

TABLE 1

MONITOR WELL ANALYSIS

LOCATION	HEAVY METALS µg/l	pH	CONDUCTIVITY µmho/cm	CYANIDE µg/l	Cr^{+6} µg/l	TOTAL PHENOLS µg/l	ORGANIC COMPOUNDS µg/l
OW-1	Be-8	6.55	950	N.D	N.D	N.D.	BE39(napthalene)-63 BE13(bis(ethyl hexyl)phthalate)-125 BE29(di-N-octyl phthalate)-11 trichloropropene 144 trimethyl benzene 45 ethenyl methyl benzene 45 bromocyclo hexene-84 hexahydro Azepinone 114
OW-1A	Be-8 Zn-55	6.12	520	N.D.	N.D.	62	BE13-181 BE29-14 hexahydro Azepinone 60
OW-2	Zn-37	6.68	110	N.D.	N.D.	N.D.	VO22(methylene chloride)-33 BE13-15
OW-3	Zn-32	7.06	900	N.D.	N.D.	N.D.	VO22-31 BE13-17 hexahydro Azepinone 202
OW-4	Be-6 Zn-26	7.12	430	N.D.	N.D.	N.D.	BE13-112
OW-5	Zn-50	6.19	380	N.D.	N.D.	N.D.	VO22-134 BE13-50 BE39-15 trichloropropone 53 trimethyl hexene 100 Bromocyclo hexene 18 hexahydro Azepinone 17
OW-6	Zn-35	6.53	440	N.D.	N.D.	N.D.	VO22-126 BE39-14
OW-7	As-18 Zn-16	6.01	350	N.D.	N.D.	N.D.	VO22-16 BE39-20
OW-8	As-2 Zn-41	7.53	590	N.D.	N.D.	N.D.	VO22-11 BE13-876
OW-9	Cu-20 Zn-28	7.53	1250	N.D.	N.D.	73	BE39-20 BE13-697 BE29-18 trichloropropone-50 trimethyl hexene-80 hexahydro Azepinone 17

BE 39 (NAPHTHALENE)

TABLE 2

LOCATION	HEAVY METALS µg/l	pH	CONDUCTIVITY µmho/cm	CYA. µg/l	Cr^{+6} µg/l	TOTAL PHENOLS µg/l	ORGANIC COMPOUNDS µg/l
OW-10	As-2 Cu-840 Zn-5700	5.20	390	N.D.	N.D.	N.D.	VO22(methylene chloride)-10 BE13(Bis(ethylhexyl)phthalate)-42
OW-11	As-8 Zn-85	6.01	670	N.D.	N.D.	N.D.	VO22-28 BE13-21
OW-12	Aq-10 As-26 Ba-230 Cr-120 Cu-40 Ni-80 Zn-58 Be-5	7.63	>7500	94	N.D.	390	methylene chloride-19 VO3(Benzene) 491 VO25(Toluene) 1100 AE10(phenol)-236 BE39(napthalene)-68 BE13(phthalate)-1090 methyl phenol-689 cyclo heptatriene-1970 [1,1-biphenyl]-3-01-90 Sulfonyl bis benzene - 984 [1,1 biphenyl] -2,2-diol 54
OW-13	As-7 Pb-120 Zn-8 Be-7	7.52	1400	N.D.	N.D.	N.D.	dichlorotrifluoro ethane-190 BE13-2370 BE29(Di-N-Octyl phthalate)9-23 sulfonyl bis benzene 81
OW-14	As-9 Zn-540 Be-8	6.13	1600	N.D.	N.D.	N.D.	Toluene 114 BE13-1240 BE39-74 BE29-42 trichloropropene-72 trimethyl benzene-21 ethenyl methyl benzene 17 bromocyclo hexane 38 sulfonyl bis benzene 37
OW-15	Zn-31 Be-8	6.50	510	N.D.	N.D.	N.D.	BE13-108
OW-16	As-5 Ba-200 Cr-100 Ni-60 Zn-143 BE-6	7.44	>7500	70	N.D.	1900	Acetone-2110 MEK 276 4-methyl pentanone-242 toluene-950 BE39-132 AE10-95 BE13-204 BE29-155 benzaldehyde-64 cyclo heptatriene 2540 methyl butanoic acid 512 methyl phenol 888

TABLE 2 cont'd

LOCATION	HEAVY METALS µg/l	pH	CONDUCTIVITY µmho/cm	CYANIDE µg/l	Cr^{+6} µg/l	TOTAL PHENOLS µg/l	ORGANIC COMPOUNDS µg/l
OW-17	As-16 Ni-60 Pb-70 Sb-16 Zn-112 Be-9	6.90	>7500	37	N.D.	7840	Benzene-747 Tetrachloro ethane-16 Toluene 177 AE10-453 BE13-341 BE29-126 BE39-83 bromo cyclohexene 35 [1,1-biphenyl] 2-01 97 unknown 119 sulfonyl bis benzene 227 [1,1-biphenyl]-3-01 127
OW-18	Cu-150 Zn-6090 Be-7	5.58	950	N.D.	N.D.	N.D.	VO26(Trans-1, 2-dichloroethylene)-10 VO29(trichloroethylene)-16 BE15(Butyl Benzyl phthalate)-73 BE13-2200 BE29-180 phthalates-61 trimethyl tridecatriene nitrile-163
OW-18a	Cu-80 Zn-126 Be-7	6.43	1000	N.D.	N.D.		BE13-352
OW-19	As-7 Zn-47,000	6.19	540	N.D.	N.D.	N.D.	N.D.
OW-19a	As-31 Zn-36	6.96	480	N.D.	N.D.	N.D.	Hexahydroazepinone - 26 Unknown extractible 14 " " 16 " " 46 " " 16 " " 17 " " 14 " " 36 " " 22
OW-20	As-14 Zn-20	8.42	640	N.D.	N.D.	N.D.	
OW-20a	As-106 Zn-24	6.12	900	N.D.	N.D.	N.D.	

TABLE 2 cont'd

Monitor Wells with Elevated VOC Analysis

LOCATION	8/82 PRIORITY POLLUTANT - µg/l	8/82 OTHER COMPOUNDS - µg/l	8/16/83 or 8/30/83 PRIORITY POLLUTANT - µg/l	8/16/83 or 8/30/83 OTHER COMPOUNDS - µg/l	9/29/83 VOC PRIORITY POLLUTANTS - µg/l	9/29/83 OTHER VOC COMPOUNDS - µg/l
OW-12	BE39-15	Methyl Butanoic acid 121 Benzoldehyde 22 Dihydrotetrazine 102 Benzene Acetic Acid 1850 Bis Sulfonyl Benzene 651	Benzene 491 toluene 1100 BE13 1090 BE39 68	bis sulfonyl benzene 989 cycloheptatriene-1970	Benzene 203 toluene 355	Acetone 71
OW-14	0	0	Toluene 114	Trichloropropene 72 Trimethyl benzene 21 Ethenyl methyl benzene 17 Bromocyclohexane 38 Bis sulfonyl benzene 37	Toluene 13	phthalates- 42
OW-16	Not Installed		Toluene 950	Acetone 2110 MEK 276 4-methyl pentanone 242	*Toluene 32600/31900	*Acetone 1410/1450 *2-propanol 49/40 *MEK 216/211 *3-methyl furan 14/28 *4-methyl pentanone 48/70
OW-17	Not Installed		Benzene 747 Toluene 177 Tetrachloro-ethane 16		Benzene 402 Toluene 203	0

*duplicate sample

TABLE 3

EP Toxicity Tests of Soil Composites

Composite	Sample Location	Sample Depth-Ft	Heavy Metal	Heavy Metal Concentration Soil Composite PPM (µg/g)	EP Extract PPB (µg/l)	Percent of Soil Metal Extracted
#1	29450	1	As	169	N.D.	N.D.
	29450	3	Cr(total)	229	11	0.1%
	29450	5	Cr^{+6}	Not Analyzed	N.D.	N.D.
	30360	1	Cu	200	50	0.5%
			Hg	1.8	N.D.	N.D.
			Pb	738	110	0.3%
			Zn	314	1630	10.4%
#2	30360	5	As	306	N.D.	N.D.
	30360	7	Cr(total)	798	N.D.	N.D.
	39210	1	Cr^{+6}	Not Analyzed	N.D.	N.D.
	39210	3	Cu	298	29	0.2%
			Hg	2.1	N.D.	N.D.
			Pb	991	N.D.	N.D.
			Zn	462	363	1.6%
#3	39210	5	As	621	N.D.	N.D.
	42360	1	Cr(total)	119	N.D.	N.D.
	42360	3	Cr^{+6}	Not Analyzed	N.D.	N.D.
	42360	5	Cu	881	226	0.5%
			Hg	1.7	N.D.	N.D.
			Pb	1943	20	0.02
			Zn	729	2920	8%
#4	43330	1	As	43	N.D.	N.D.
	52300	1	Cr(total)	943	11	0.02%
	52300	11	Cr^{+6}	Not Analyzed	N.D.	N.D.
	52300	26	Cu	101	N.D.	N.D.
			Hg	0.5	N.D.	N.D.
			Pb	533	N.D.	N.D.
			Zn	208	581	5.6%

N.D. - Indicates less than instrumental detection levels

As	<30 PPB
Cr(total)	<3 PPB
Cr^{+6}	<14 PPB
Cu	<2 PPB
Hg	<0.5 PPB
Pb	<20 PPB
Zn	<1 PPB

TABLE 4

Borehole Gas Emission Rates

(Volume of Collection Bag = 4.2 Cubic Feet)

Bore Hole	Test	Meter Readings: Combustible Gas - %	Meter Readings: H_2S PPM	Time to Fill Bag minutes	Generation Rate (cfm)	
9	1	34	>250	18:00	0.23	
	2	52	>250	16:45	0.25	
	3	42	>250	13:00	0.32	
						Avg. 0.27
10	1	40	>250	2:55	1.44	
	2	46	>250	3:45	1.12	
	3	44	>250	3:30	1.20	
						Avg. 1.25
11	1	44	>250	21:30	0.20	
	2	52	>250	26:30	0.16	
	3	47	>250	22:15	0.19	
						Avg. 0.18
12	1	30	>250	48	0.091	
	2	24	>250	41	0.110	
						Avg. 0.101
13	1	24	>250	182	0.023	
	2	28	>250	210	0.021	
						Avg. 0.022
20	1	46	0/115	1114	0.0038	
21	1	56	0	6:35	0.64	
	2	52	0	7:50	0.54	
	3	48	0	5:35	0.76	
						Avg. 0.65

TABLE 5

Borehole Air Analysis

Bore Hole	Location	Compound	Conc. (PPM)
BH 9	52451	hydrogen sulfide	5700/5530 (1)
		2-propanethiol	180
		methanethiol	64
		2-butanethiol isomer	3.4
		ethanethiol	3.1
		methyl furan isomer	1.3
		trichlorofluoromethane	0.59
BH 10	51411	hydrogen sulfide	1.8%/2.1% (1)
		methanethiol	50
		2-propanethiol	42
		ethanethiol	8
		carbon oxide sulfide	6.3
		benzene	1.1
BH 11	52431	hydrogen sulfide	5800/5600 (1)
		2-propanethiol	42
		methanethiol	20
		ethanethiol	6.5
		carbon oxide sulfide	5.4
		2-butanethiol isomer	2.2
BH 12	52381	hydrogen sulfide	1.9%/1.9% (1)
		methanethiol	150
		2-propanethiol	55
		ethanethiol	17
		carbon oxide sulfide	13
		benzene	11
		carbon disulfide	11
		dimethyl disulfide	7.5
		methyl furan isomer	1.4
		2-butanethiol isomer	1.1
		toluene	1.1
BH 13	53423	hydrogen sulfide	2.0%/2.1% (1)
		2-propanethiol	180
		methanethiol	110
		ethanethiol	19
		carbon oxide sulfide	12
		dimethyl disulfide	7.8
		2-butanethiol isomer	5.5
		carbon disulfide	3.3
		benzene	1.5
		trichlorofluoromethane	0.63

(1) duplicate analyses, same sample

TABLE 6

Bore Hole	Location	Compound	Conc. (PPM)
BH 14	36532	hydrogen sulfide	2000/1900 (1)
		2-propanethiol	9
		methanethiol	2.4
BH 16	37521	hydrogen sulfide	51/43 (1)
		2-propanol	20
		2-propanethiol	6.6
		methanethiol	4.3
		carbon oxide sulfide	4.1
		ethanethiol	4
		dimethyl disulfide	1.1
BH 17	39551	2-propanethiol	11
		methyl furan isomer	2.8
		ethanethiol	2
BH 19	51301	hydrogen sulfide	200/200 (1)
		2-propanethiol	17
		benzene	2.3
		toluene	1.6
		trichlorofluoromethane	1.6
BH 20	52301	hydrogen sulfide	710/690 (1)
		toluene	0.73
BH 21	51291	hydrogen sulfide	58/50 (1)
		benzene	1.2
		toluene	0.76
BH 22	40601	(nothing detected)	
BH 23	29412	hydrogen sulfide	5300/4600 (1)
		2-propanethiol	47
		methanethiol	18
		toluene	3.9
		ethanethiol	2.5
		bis(2-methylpropyl)disulfide	1.9
BH 24	44521	(nothing detected)	
BH 25	43571	hydrogen sulfide	240/250 (1)
		methanethiol	220
		ethanethiol	77
		dimethyl disulfide	1.6

(1) duplicate analyses, same sample

TABLE 6 cont'd

DIRECT SENSORY EVALUATION OF BORE HOLE GASES

Bore Hole No.	Dilutions to Threshold[1]	Dose/Response Analysis[2] -A Slope	B Int.	r Regr. Coef.	Dilutions to TIA = 1	Odor Characteristics
9	64,000	1.23	6.12	0.970	14,000	H_2S, X-SH, sour, fatty acid, fecal, oniony-SH, solventy
10	$>1 \times 10^6$	1.40	8.87	0.973	430,000	H_2S
11	256,000	1.12	6.29	0.994	50,000	H_2S, rubbery, sulfide, oniony
12	512,000	1.66	9.89	0.993	230,000	H_2S
13	512,000	1.21	6.99	0.947	86,000	H_2S
14	128,000	1.37	7.30	0.994	40,000	H_2S, trace fecal, trace sour
16	128,000	0.83	4.49	0.974	15,000	Cheesey sour, dirty sour, burnt sweet, trace fecal (butyric, propionic, and isovaleric acids)
17	8,192	0.73	3.35	0.989	2,000	Animal, sweet fragrance, fecal, DMS, musty, sulfidy (WWTP)
19	4,096	1.16	4.55	0.987	1,400	Sulfidy, sour, oniony-SH, tarry, fecal
20	32,000	0.97	4.53	0.994	4,200	Sour, oniony, SH, vegetable sulfide, rubbery, slightly fecal and H_2S, naphthalene (moth balls)
21	4,096	1.04	4.22	0.993	1,200	Oniony, sulfidy, animal, horsey, rubbery, tarry, fecal

Arthur D. Little, Inc.

TABLE 7

DIRECT SENSORY EVALUATION OF BORE HOLE GASES

Bore Hole No.	Dilutions to Threshold[1]	Dose/Response Analysis[2] -A Slope	B Int.	r Regr. Coef.	Dilutions to TIA = 1	Odor Characteristics
22	2,048	1.07	3.73	0.992	350	Horsey, animal, fecal, leathery, sulfide, oniony
23	512,000	0.99	6.06	0.946	135,000	H_2S, trace oniony, oniony-SH, rubbery, animal, fecal
24	2,048	0.83	2.93	0.967	200	Fecal, rubbery sulfide, vegetable sulfide, animal, musty, WWTP
25	512,000	0.99	5.71	0.982	55,000	Fermented sour, cheesey, garbagey

[1] Recognized by 100% of the panel participants.

[2] Results of best fit for all data, TIA = A (log Dilutions) + B.

TABLE 7 cont'd

SENSORY EVALUATIONS OF

ADSORBED BORE HOLE ODORS

Bore Hole No.	Odor Characteristics	
	Air Eluted	Solvent Eluted
9	Oniony, sour, sulfidy, burnt oniony	Oniony (Pr or allyl-SH) fecal (skatole), solventy naphthalene)
10	Oniony, horsey, animal, fecal	(Me or ET)-SH, Pr-SH, fecal and fatty acid, rubbery
11	Oniony, fecal, rubbery, sulfide, DMS or DMDS	Oniony, (Pr or allyl-SH), fecal, p-dichlorobenzene
12	Oniony, horsey, DMS, animal	Oniony-SH, rubbery-SH (TBM), musty-earthy, horsey, trace skatole
13	Corny (DMS), barny, fecal, vegetable sulfide	-SH (TBM?), musty, animal, fecal, skatole
14	Fecal, burnt sweet, animal	Rubbery-SH or sulfide, musty-earthy, fecal (WWTP)
16	N/A	N/A
17	N/A	N/A
19	Oniony, garlicky, rubbery	-SH (Me or ET), tarry, oniony, WWTP
20	N/A	N/A
21	Trace acetic acid, sulfidy, horsey, animal	Sulfidy, fuel oil, WWTP
22	N/A	N/A
23	Oniony, sour, rubbery, animal, horsey, fecal	-SH, fuel oil WWTP, fecal
24	N/A	N/A
25	Putrid, cheesey, garbagey fermented sour, trace fecal, coffee-like-SH	Cheesey, burnt, animal, fecal (WWTP), benzene-tarry (trace methyl benzene)

TABLE 8

GROUND WATER REMEDIATION METHODS
OMITTED FROM FURTHER EVALUATION

Ground Water Interception/Recovery

Remedial Method	Omission Rationale
1. Containment barriers, slurry walls or grout curtains with/ without ground water pumping	Feasibility and Reliability, Environmental Effectiveness, Cost: A slurry wall/grout curtain around entire site is not feasible as a result of the integrity of the bedrock floor underlying the site. The bedrock to the east, west, and south is frequently fractured, permeable and dips steeply under the site. This will not be suitable as a floor for a slurry wall or grout curtain. A slurry wall would significantly heighten the water table at the site and ground water pumpage would be required anyway. Permeabilities of sediments underlying the site and adjacent to the buried valley are low, so many wells would be required. A slurry wall/grout curtain upgradient of the site to reduce inflow of ground water is not feasible because most ground water flowing in the unconsolidated deposits under the site originates as precipitation on the site. Very little flow into the site occurs from unconsolidated deposits upgradient of the site. This would, therefore, have no effect on the migration of the benzene plume.
2. Water table adjustment to minimize flow through waste material	Environmental Effectiveness: Ground water flowing through the unconsolidated deposits underlying the site originates as precipitation. Very little water enters the site through unconsolidated deposits upgradient, so upgradient pumpage would a have negligible effect on total flow rate.

TABLE 9

GROUND WATER REMEDIATION METHODS
OMITTED FROM FURTHER EVALUATION

Ground Water Treatment

Remedial Method	Omission Rationale
1. Treat recovered ground water with ion exchange resins	Feasibility and Reliability, Environmental Effectiveness, Cost: Treatment via ion exchange requires pretreatment to remove solids, competitive ions and other resin fouling agents. Additionally, multiple exchange resins would be required to remove potential range of ions identified in soils and ground water. Pretreatment requirements, number and life expectancy of resin columns increases capital cost significantly above other alternatives without equivalent increase in environmental effectiveness.
2. Treat recovered ground water with reverse osmosis	Feasibility and Reliability, Environmental Effectiveness: Reverse osmosis has extremely stringent pretreatment requirements to avoid immediate failing. The pretreatment steps will improve water quality to acceptable levels (with the exception of arsenic removal) without incorporation of reverse osmosis or the costs inherent in the process. Therefore, increased cost with no significant increase in environmental effectiveness renders this process unnecessary for attaining required low effluent concentrations.
3. Treat recovered ground water with PAC	Environmental Effectiveness, Cost: PAC offers no advantage over GAC for treatment efficiency in Woburn-type application. Filtration required prior to discharge and disposal of spent PAC after filtration increase O&M requirements and cost far in excess of GAC with no practical environmental benefits.
4. Permeable treatment bed for VOC, solids removal	Feasibility, Reliability, Environmental Effectiveness: Effectiveness of this technology is not well developed due to short circuiting/ channeling and nondistributed contact.

TABLE 10

GROUND WATER REMEDIATION METHODS
OMITTED FROM FURTHER EVALUATION

Ground Water Discharge

Remedial Method	Omission Rationale
1. Treatment, discharge to MDC sewer	MDC cannot accept additional flow until court-ordered mandates are in place
2. Direct discharge to MDC sewer	Same as above.
3. Treatment, discharge to aquifer upgradient via trench, pond or leach field	Feasibility and Reliability: Technically feasible only for small volumes of water such as would be generated by hot spot pump out. Greater than 50-75 gpm would overload the shallow aquifer and cause surface flooding. This is particularly a problem in developed areas.
4. Treatment, discharge to aquifer downgradient via trench, pond or leach field	Same as above except a slightly greater (100 gpm) quantity might be accomodated. However, extensive development in the area north of Mishawam Road limits space for recharge facility. Flooding of adjacent developed area is likely.
5. Treatment, discharge to aquifer via well injection downgradient	Might accomodate up to 400 gpm and avoid flooding and land availability problems, but additional well costs and treatment (to avoid plugging) without any significant advantages.

TABLE 11

FUNCTIONAL ANALYSIS MATRIX -- FUNCTIONAL AREA: GROUND WATER INTERCEPTION/RECOVERY

Evaluation Criteria	Weighting Factor	On-Site Hot Spot Recovery		Downgradient of Site Recovery of Ground Water		Downgradient of Plume Recovery of Ground Water	
		Rating	Comment	Rating	Comment	Rating	Comment
1. Reliability	1.1	4	Difficult to define hot spot	5	Would collect the majority of presently known concentrations of benzene	5	Would ensure that no benzene migrates downgradient
2. Constructibility	0.6	5	Easiest to install due to minimum number of wells installed at shallower depth	4	Fewer wells than full downgradient recovery	2	Up to 5 recovery wells to withdraw the entire plume
3. Implementation Time Frame	0.5	5	Pumping duration shorter due to relatively undiluted contaminant plume	3	May require as long as 11 years due to variable flowrates	2	Long period to set up, operate and complete recovery of migrating benzene
4. Environmental Effectiveness	2.0	3	Will reduce the potential risk to the downgradient receptor population	4	Will minimize the potential risk to the downgradient receptor population	5	Will nullify the potential risk to the downgradient receptor population
Total		15.9		17.4		18.9	

Note: Ratings range from 1 (poor) to 5 (excellent).

TABLE 12

TABLE 13

FUNCTIONAL ANALYSIS MATRIX -- FUNCTIONAL AREA: GROUND WATER TREATMENT

Evaluation Criteria	Weighting Factor	Air Stripping		Biological Treatment, Air Stripping		Odor Control, Air Stripping		Biological Treatment, Air Stripping, Precipitation/Flocculation	
		Rating	Comment	Rating	Comment	Rating	Comment	Rating	Comment
1. Reliability	1.1	4	Impacted by alkalinity and iron	3	Biological treatment requires additional operator attention	4	Impacted by alkalinity and iron	2	Dependent on continual process monitoring of mixing speed, chemical addition rate and overflow rate
2. Constructibility	0.6	5	Easily constructed as package system	3	Biological system requires additional unit, although package system is available	5	Easily constructed as package system	2	Construction involves mixing, flocculation, sedimentation, sludge withdrawal and storage areas
3. Implementation Time Frame	0.5	4	Can be on-line within 2 or 3 months	3	Increased number of process components increases implementation time frame	4	Can be on-line within 2 or 3 months	3	Implementation time frame is longer due to the complexity of the process and the number of process components
4. Environmental Effectiveness	2.0	4	Should alleviate ground water problems if clean background air is available and no other organic compounds other than benzene and toluene identified	4	Biological treatment required only for water discharge	3	Odor control with hydrogen peroxide would reduce organic content of waste stream making subsequent stripping easier. Phenol removal difficult	4	Provides most thorough treatment, but sludge dewatering and disposal practices must be managed properly to prevent contaminant release
Total		17.4		14.4		15.4		12.9	

Note: Ratings range from 1 (poor) to 5 (excellent).

FUNCTIONAL ANALYSIS MATRIX -- FUNCTIONAL AREA: GROUND WATER DISCHARGE

Evaluation Criteria	Weighting Factor	Pump, Treat, Recharge		Pump, Treat, Discharge to Surface Water	
		Rating	Comment	Rating	Comment
1. Reliability	1.1	1	Reliability of the process varies with the site subsurface conditions to be determined. May not be feasible without flooding and direct discharge to surface water	3	Potential for process upsets and degradation of receiving waters requires more complicated treatment
2. Constructibility	0.6	2	May require deep injection wells to prevent flooding of developed areas	3	Involves less complex construction than either recharge option
3. Implementation Time Frame	0.5	3	Extensive due to required SDWA/UIC permit, subsurface investigation and construction of recharge system	3	Implementation time less than the recharge options
4. Environmental Effectiveness	2.0	4	Recharged water would meet DWS	4	Requires treatment to a level that ensures maintenance of surface water quality standards
Total		11.8		14.6	

Note: Ratings range from 1 (poor) to 5 (excellent).

TABLE 14

COST COMPARISON OF SELECTED ALTERNATIVES FROM GROUND WATER FUNCTIONAL ANALYSIS RESULTS

Remedial Alternative/Description	Capital Cost	O&M Cost	Total Implementation Cost	Recommended Ranking	Ranking Rationale
I. Hot spot recovery, treatment with odor control, air stripping, recharge on-site	$0.8 M	$0.14[2]	$0.94M	3	- Least stringent treatment required, roughly one-fourth the cost of highest ranked alternative
II. Downgradient of site, recovery, treatment with odor control, air stripping, discharge to surface water	$1.25 M	$2.4 M[3]	$3.65 M	1	- Stringent treatment required to meet surface water criteria.
III. Downgradient of plume recovery, treatment with odor control, RBC, air stripping, metals removal discharge to surface water	$4.5 M	$6.5 M[3]	$11.0 M	2	- More than triple the cost of highest ranked alternative without significant benefit

Notes:

1. See Appendix for detailed Cost Estimates.
2. 6-Month O&M period for Alternative I
3. 15-Year O&M period for Alternatives II and III.

TABLE 15

WASTE DEPOSIT AND CONTAMINATED SOIL/SEDIMENT CONTROL
REMEDIAL METHODS OMITTED FROM FURTHER CONSIDERATION

Remedial Method	Omission Rationale
Soil/Sediment Treatment	
1. Stabilization/solidification/ reburial	Cost, Environmental Effectiveness, Negative Environmental Impact Potential, Feasibility and Reliability: Cost of encapsulation/reburial of any or all of the wastes on-site is an order of magnitude greater than burial alone. Wastes must undergo thorough analytical characterization and pilot stabilization testing to ensure compatibility with a specific waste. The heterogeneous nature of the hide piles renders this technique infeasible.
2. Encapsulation/reburial	Feasibility and Reliability: The encapsulation process has yet to be applied on a large commercial scale under actual field conditions.
3. Incineration/residue reburial	Feasibility and Reliability: Incineration is infeasible for heavy metal removal.
4. Wet air oxidation/residue reburial	Same rationale as No. 3 above.
5. Land farming	Feasibility and Reliability: Landfarming infeasibile for heavy metals removal.
6. In situ microbial degradation	Same rationale as No. 5 above.
7. In situ solution mining	Feasibility and Reliability: Requires homogeneous waste that is mobile and that can be entrained in a solvent phase, contaminants in the soils have proven immobile over time and hide piles present a very heterogeneous environment.
8. In situ neutralization/ detoxification	Feasibility and Reliability, Negative Environmental Impact Potential: Heterogeneous nature of wastes result in the potential for poor contact with neutralization medium. Toxic by-products could be generated as a result of the heterogeneous mixture of wastes and presence of heavy metals.

TABLE 16

FUNCTIONAL ANALYSIS MATRIX -- FUNCTIONAL AREA: CONTAMINATED SOILS

Evaluation Criteria	Weighting Factor	Alternative I Rating	Alternative I Comment	Alternative II Rating	Alternative II Comment	Alternative III Rating	Alternative III Comment	Alternative IV Rating	Alternative IV Comment
1. Reliability	1.1	4	Reduces both potential for contact and rainwater infiltration	4	Reduces both potential for contact and rainwater infiltration	4	Reduces both potential for contact and rainwater infiltration	4	Reduces both potential for contact and rainwater infiltration
2. Constructability	0.6	4	Common civil engineering technique	4	Common civil engineering technique	4	Common civil engineering technique	4	Common civil engineering technique
3. Impelmentation Time Frame	0.5	3	Compaction required for large soil volume	3	Compaction required for large soil volume	4	Less layers than Alternatives I and II	2	More layers than Alternatives I and II
4. Environmental Effectiveness	2.0	4	Some portions of site may be difficult to completely seal	3	Additional infiltration compared to Alternatives I and IV	4	Would treat metals in ground water if necessary	4	Some portions of site may be difficult to completely seal
5. Future Land Use	0.5	1	Precludes development on 70 acres	1	Precludes development on 70 acres	3	Does not preclude development. Requires deed restrictions.	1	Precludes development on 70 acres
Total		16.8		14.8		18.3		16.3	

IN RI/FS	IN ROD
I	S-2
II	S-3
III	S-4
IV	S-5
V	S-6
VI	S-7
VII	S-8
VIII	S-9
IX	S-10
X	S-11
XI	S-12

Note:

Ratings range from 1 (poor) to 5 (excellent).
Alternative I - 24" clay, 6" cover, vegetate.
Alternative II - 6" clay, 18" fill, 6" cover, vegetate.
Alternative III - 24" offsite fill, 6" cover, vegetate
Alternative IV - 20 mil PVC liner, 12" sand beds, 12" fill, 6" cover, vegetate

TABLE 17

FUNCTIONAL ANALYSIS MATRIX -- FUNCTIONAL AREA: CONTAMINATED SOILS (Continued)

Evaluation Criteria	Weighting Factor	Alternative V Rating	Alternative V Comment	Alternative VI Rating	Alternative VI Comment	Alternative VII Rating	Alternative VII Comment	Alternative VIII Rating	Alternative VIII Comment
1. Reliability	1.1	3	Reduces potential for contact	4	Allows future site development on portion of property and minimizes potential for contact	5	Allows site development on large portion of property	5	Allows site development on large portion of property
2. Constructibility	0.6	5	Common Civil engineering methods	2	Requires access roads, relocation system design and leachate collection system	2	Requires safety precautions and coordination	2	Requires safety precautions and coordination
3. Implementation Time Frame	0.5	5	Short-term due to minimal earthwork required	1	Long-term due to large volume of soil being excavated and and relocated fill required	1	Long-term due to large volume of soil being excavated, relocated and back-	2	Less time than Alternative VII since no backfill required
4. Environmental Effectiveness	2.0	3	Would treat metals in ground water if necessary	3	Excellent long-term effectiveness due to odor	4	Would limit infiltration and gaseous emissions	4	Would limit infiltration and gaseous emissions
5. Future Land Use	0.5	4	Does not preclude development of site. Requires deed restrictions.	3	Precludes development on 13.6 acres	3	Precludes development on 15 acres	3	Precludes development on 15 acres
Total		16.8		13.6		16.7		17.2	

Note:

Ratings range from 1 (poor) to 5 (excellent)
Alternative V - 6 inch cover, vegetate, deed restrictions
Alternative VI - Construct RCRA landfill
Alternative VII - Consolidate and cover with 24" backfill, 6" soil, backfill
Alternative VIII - Consolidate and cover with 24" backfill, 6" soil, no backfill

TABLE 17 cont'd

TABLE 17 cont'd

FUNCTIONAL ANALYSIS MATRIX -- FUNCTIONAL AREA: CONTAMINATED SOILS (Continued)

Evaluation Criteria	Weighting Factor	Alternative IX Rating	Alternative IX Comment	Alternative X Rating	Alternative X Comment	Alternative XI Rating	Alternative XI Comment
1. Reliability	1.1	3	Reduces potential for contact	4	Allows future site development on portion of property and minimizes potential for contact	3	Reduces potential for contact
2. Constructibility	0.6	5	Limited excavation, fence and deed restrictions	4	Common civil engineering technique	5	Common civil engineering technique
3. Implementation Time Frame	0.5	4	Readily implemented	4	Readily implemented	4	Short-term due to less earthwork required
4. Environmental Effectiveness	2.0	2	Would treat metals in ground water if necessary. Less cover than other options.	4	Would treat metals in ground water if necessary	3	Would treat metals in ground water if necessary
5. Future Land Use	0.5	5	Does not preclude development. Required deed restrictions	4	Does not preclude development. Required deed restrictions.	4	Does not preclude development. Required deed restrictions
Total		14.8		18.8		16.3	

Note:

Ratings range from 1 (poor) to 5 (excellent)

Alternative IX - Limited excavation and relocation of ditch along New Boston Streets, fence and deed restrictions

Alternative X - Limited excavation and relocation of ditch along New Boston Street, fence and deed restrictions. Cover areas in top 2 feet greater than either 300 ppm As, 600 ppm Pb or 1,000 ppm Cr with 30 inch fill/soil.

Alternative XI - Limited excavation and relocation of ditch along New Boston Street, fence and deed restrictions. Cover areas in top 2 feet greater than either 300 ppm As, 600 ppm Pb or 1,000 ppm Cr with 6" fill/soil

TABLE 18

COST COMPARISON OF SELECTED ALTERNATIVES FROM CONTAMINATED SOILS FUNCTIONAL ANALYSIS RESULTS

Remedial Alternative/Description	Functional Analysis Value	Capital Cost	O&M Cost	Total Implementation Cost	Ranking	Ranking Rationale
I 24" clay, 6" cover, vegetate	16.8	$22.7 M	$1 M	$23.7 M	8	- Good functional analysis - High cost
II 6" clay, 18" fill, 6" cover, vegetate	14.8	$12.3 M	$1 M	$13.3 M	10	- Low functional analysis - Moderate cost
III 24" fill, 6" cover, vegetate	18.3	$ 8.2 M	$1 M	$ 9.2 M	2	- High functional analysis - Moderate cost
IV 20 mil PVC liner, 12" sand, 12" fill, 6" cover, vegetate	16.3	$11.4 M	$1 M	$12.4 M	7	- Good functional analysis - Moderate cost
V 6" cover, vegetate, deed restrictions	16.8	$ 4.1 M	$1 M	$ 5.1 M	3	- Good functional analysis - Low cost
VI RCRA landfill	13.6	$79.0 M	$1 M	$80.0 M	11	- Lowest functional analysis - Highest cost
VII Consolidate, cover with 30" fill, 20 mil PVC, backfill of excavated areas	16.7	$18.0 M	$1 M	$19.0 M	9	- Good functional analysis - High cost
VIII Consolidate, cover with 30" fill, 20 mil PVC, no backfill of excavated areas	17.2	$ 9.0 M	$1 M	$10.0 M	5	- High functional analysis - Moderate cost
IX Limited excavation and relocation of ditch along New Boston Street, fence, deed restrictions	14.8	$ 2.3 M	$1 M	$ 3.3 M	6	- Low functional analysis - Lowest cost

TABLE 18 cont'd

COST COMPARISON OF SELECTED ALTERNATIVES FROM
CONTAMINATED SOIL FUNCTIONAL ANALYSIS RESULTS (Continued)

Remedial Alternative/Description	Functional Analysis Value	Capital Cost	O&M Cost	Total Implementation Cost	Ranking	Ranking Rationale
X Cover areas in top 2' greater than either 300 ppm As, 600 ppm Pb or 1,000 ppm Cr with 30 inch fill/soil	18.8	$ 5.3 M	$1 M	$ 6.3 M	1	- Highest functional analysis - Moderate cost
XI Cover areas in top 2' greater than either 300 ppm As, 600 ppm Pb or 1,000 ppm Cr with 6 inch fill/soil	16.3	$ 3.0	$1 M	$ 4.0 M	4	- Good functional analysis - Low cost

AIR EMISSIONS METHODS OMITTED FROM FURTHER CONSIDERATION

Remedial Method	Omission Rationale
Gas Control	
1. Urea-Formaldehyde barriers	Feasibility and Reliability: Effective permeability of foam can be unreliable due to frequently encountered installation problems.
2. Tall Stack Dispersion	Feasibility and Reliability: Under current policy, tall stack dispersion is not acceptable to Massachusetts DEQE for odor control.
Gas Treatment	
1. Chemical Oxidation	Environmental Effectiveness: Chemical oxidation using ozone or hydrogen peroxide has potential to generate hazardous waste.
2. Ion Exchange	Feasibility and Reliability: Not as reliable as more commonly used carbon adsorption.
3. Excavate and Remove East Hide Pile	Cost, Negative Environmental Impact Potential: Cost would be an order of magnitude greater than other feasible alternatives. In addition, tremendous odor generation would result from unearthing decomposing waste material.
4. Stabilization	Environmental Effectiveness: Stabilization using lime or sodium biocarbonate has not been proven effective for reducing emission rates in landfills.

TABLE 19

TABLE 20

FUNCTIONAL ANALYSIS MATRIX -- FUNCTIONAL AREA: EAST HIDE PILE

Evaluation Criteria	Weighting Factor	Alternative A-2 Rating	Alternative A-2 Comment	Alternative A-3 Rating	Alternative A-3 Comment	Alternative A-4 Rating	Alternative A-4 Comment
1. Reliability	1.1	2	Pressure buildup may jeopardize cap	4	Carbons beds will require regular maintenance to assure reliability	4	Thermal oxidation requires inspection and maintenance to assure reliability
2. Constructibility	0.6	5	Common civil engineering methods	3	Treatment unit reduces constructibility	3	Treatment unit connection to gas collection piping reduces constructibility
3. Implementation Time Frame	0.5	5	Easiest to install due to minimal earthwork and lack of collection pipes	4	Installation of gas collection system and synthetic liner may involve slight delay	4	Installation of gas collection system and synthetic liner may involve slight delay
4. Environmental Effectiveness	2.0	1	Hydrogen sulfide gas may escape via ground water or fissures	4	Will treat emissions and assure negligible internal pressure buildup	4	Will treat emissions and assure negligible interal pressure buildup
Total		9.7		16.2		16.2	

Notes:

Ratings range from 1 (poor) to 5 (excellent).

Alternative A-2- Modify slope with new fill, install synthetic membrane liner cap, cover with topsoil, and establish vegetation

Alternative A-3- Modify slope with new fill, install gas collection system piping, install synthetic membrane liner cap, cover with topsoil, establish vegetation, carbon adsorption unit and 12-foot stack

Alternative A-4- Modify slope with new fill, install gas collection system piping, install synthetic membrane liner cap, cover with topsoil, establish vegetation, thermal oxidation unit and 30-foot stack, propane storage.

COST COMPARISON OF SELECTED ALTERNATIVES FROM EAST HIDE PILE FUNCTIONAL ANALYSIS RESULTS

Remedial Alternative/Description	Capital Cost	O&M Cost	Total Implementation Cost	Recommended Ranking	Ranking Rationale
A-2 Modify slopes with new fill, install synthetic membrane liner cap, cover with top soil and establish vegetation	$1.86 M[1]	$0[2]	$1.86 M	2	Questionable reliability and environmental effectiveness
A-3 Modify slopes with new fill, install gas collection system piping, install synthetic membrane liner cap, cover with topsoil and establish vegetation, blower system, carbon adsorption unit, 12 foot stack	$2.36 M	$0.30 M[3]	$2.66 M	1	To be evaluated during pilot testing
A-4 Modify slopes with new fill, install gas collection system piping, install synthetic membrane liner cap, cover with topsoil and establish vegetation, blower system, thermal oxidation unit, 3,000 gallon propane storage tank, 20 foot stack	$2.50 M	$0.50 M[3]	$3.00 M	1	To be evaluated during pilot testing

Notes:

1. Cost includes air monitoring. See Figure 3-7 for air monitoring flowchart.
2. O&M costs for Alternative I are considered zero because these costs are absorbed in the overall site monitoring.
3. O&M costs for Alternatives II and III are based on a 15-year life.

TABLE 21

CAPITAL COST INTERCEPTOR WELL SYSTEM - HOT SPOT RECOVERY

DRILL FIVE INTERCEPTOR WELLS		$ 24,000
SUPPLY AND INSTALL FIVE 10-20 GPM SUBMERSIBLE 316SS IMPELLOR PUMPS		5,000
SUPPLY AND INSTALL WELL MANIFOLD AND DISCHARGE LINE		17,000
ELECTRIC SUPPLY FOR PUMPS		1,000
MISCELLANEOUS		2,000
INSTALL EIGHT 2" dia. PIEZOMETER WELLS		10,000
GROUNDWATER CONSULTANTS COSTS Interceptor Wells Piezometer Wells Pumping Test Start-up Pumping OW-16 Report Writing and Issue		26,000
SITE IMPROVEMENTS		
.5 Acres of Land	53,000	
30' x 40' Pre-engineered Building	76,000	
40' x 50' Curbed Concrete Slabs	11,000	
50' x 60' Fenced Enclosure	5,000	
Site Lighting, Grounding	4,000	
Furniture, Safety Supplies	1,000	
		150,000
VOC STRIPPING COST		
100 GPM Pump C.I.	3,000	
1000 ACFM Blower FRP	2,000	
Two 48"dia.x35' High Packed Towers 304SS	66,000	
Piping, Valves	9,000	
Electrical	1,000	
Instrumentation	5,000	
Painting	1,000	
		87,000

TABLE 22

ODOR REMOVAL			
	5% $Fe Cl_2$ Tank 200 Gal. PPL	1,000	
	50% H_2O_2 Tank 7000 Gal. Alum.	21,000	
	Groundwater Tnk 8000 Gal Fiberglass	10,000	
	Mixer 316 SS	2,000	
	Metering Pumps (2) 0 to 1.7 GPM	1,000	
	Pulsefeeders (2) 3 GPH 316SS	1,000	
	Agitator 1/3 HP 304 SS	1,000	
	Agitator 5 HP 304 SS	3,000	
	Piping, Valves	7,000	
	Electrical	5,000	
	Instrumentation	-	
	Insulation	1,000	
	Paint	1,000	
			54,000
	TOTAL DIRECTS		**$ 376,000**
CONSTRUCTION EXPENSE			
	6 Months Duration @ $20,000/Month		120,000
PREMIUM ON OVERTIME			5,000
ENGINEERING			50,000
	Wells $85,000 @ 5%		
	Other $150,000 + 37,000 + 54,000 @ 15%		
PUNCH LIST			5,000
SPARE PARTS			8,000
	Sub-Total		$ 564,000
CONTINGENCY & ESCALATION			226,000
	CAPITAL COST		**$ 790,000**

OPERATING AND MAINTENANCE COSTS INTERCEPTOR WELLS HOT SPOT RECOVERY

Operating and Maintenance Costs for minimum six month Duration is estimated at $140,000.

TABLE 22 cont'd

CAPITAL COST INTERCEPTOR WELL SYSTEM - 110 GPM

COSTS OF FIVE INTERCEPTOR WELL SYSTEMS		$	85,000
COSTS OF:			
Site Improvements	150,000		
VOC Stripping	87,000		
Odor Control	54,000		
			291,000
TOTAL DIRECTS		$	376,000
INDIRECT COSTS			
Construction Expense	120,000		
Premium on Overtime	5,000		
Engineering	50,000		
Punch List	5,000		
Spare Parts	8,000		
			188,000
Sub-Total		$	564,000
CONTINGENCY & ESCALATION			226,000
Sub-Total		$	790,000
BOD Removal Costs from "Handbook for Remedial Action at Waste Disposal Sites" EPA-625/6-82-006, June 1982, Pg. 229. Package Plant; Activated Sludge; Extended Aeration; 2 Stages; Includes Chlorination and Secondary Clarification.			460,000
TOTAL CAPITAL COST		**$**	**1,250,000**

TABLE 23

OPERATING AND MAINTENANCE COSTS INTERCEPTOR WELLS 110 GPM

Supplies			$14,000
H_2O_2	84#/day @ .45/#	$13,800	
$FeCl_2$	Negligible amount per year	200	
Electrical			32,000
Well Pumps (5)	7.5 HP		
Stripper Pump (2)	6.		
Blowers (2)	10.		
Metering Pumps (2)	2.		
Agitator (2)	6.		
	31.5 HP or 23.5 KW		
Building and Site Lighting 30'x40'		5.0	
Heat Tracing Assume 5 Watts/LF of Pipe 100 feet of 2"0 Pipe 6 mo. Usage Factor .6 Utilization Factor		1.8	
		30.3 KW/HR @ $.12/KWH	
Heating Assume 20 Gal/Day of Propane @ $1.50/Gal. for Six Months			5,000
Maintenance Assume 5% of Capital Cost ($376,000 x 5%)			19,000
Operation and Supervision Assume Eight Hour Shift, 365 Days @ $30/Hour			88,000
	Sub Total		$158,000

OPERATING AND MAINTENANCE COSTS BOD REMOVAL SYSTEM

Supplies		-
Electrical		3,000
Rotating Disc Aerator	3 HP	
Blowers	1	
	4 HP or 2.98 KW/HR @ $.12/KWH	
Heating		-
Maintenance		12,000
Assume half of total cost of $460,000 is equipment. Maintenance costs are 5% ($230,000 x 5%)		
Operation and Supervision		-
Included with Interceptor Wells		
	Sub Total	**15,000**
TOTAL INTERCEPTOR WELLS		**$158,000**
BOD REMOVAL		**15,000**
	Sub Total	**$173,000**
Contingency		52,000
TOTAL OPERATING AND MAINTENANCE COSTS		**$225,000**

TABLE 24

ALTERNATIVE GW-4

CAPITAL COST INTERCEPTOR WELL SYSTEM - 360 GPM

COSTS OF FIVE INTERCEPTOR WELL SYSTEMS $85,000. Costs are increased 30% to account for larger diameter wells and installation of two wells in a lake in lieu of dry land.		$ 110,000
COSTS OF:		
Site Improvements	150,000	
VOC Stripping	87,000	
Odor Control	54,000	
Increase Size of Ageing Tank in Odor Control	21,000	
		312,000
TOTAL DIRECTS		$ 422,000
CONSTRUCTION EXPENSE 7 Months @ $20,000/Month		140,000
PREMIUM ON OVERTIME		5,000
ENGINEERING Wells - $110,000 @ 5% Other - $150,000 + 87,000 + 75,000 @ 15%		53,000
PUNCH LIST		5,000
SPARE PARTS		8,000
Sub-Total		$ 633,000
CONTINGENCY & ESCALATION		257,000
Sub-Total		$ 890,000
BOD Removal Costs from "Handbook for Remedial Action at Waste Disposal Sites" EPA-625/6-82-006, June 1982, Pg. 229. Package Plant; Activated Sludge; Extended Aeration; 2 Stages; Includes Chlorination and Secondary Clarification.		460,000
TOTAL CAPITAL COST		**$1,350,000**

OPERATING AND MAINTENANCE COSTS INTERCEPTOR WELLS 360 GPM

Total Operating and Maintenance Costs (Present worth in 1985 dollars)	$2,360,000

Assumed to be the same as 110 GPM

TABLE 25

CAPITAL COST HEAVY METALS REMOVAL SYSTEM 110 GPM

Process Equipment		
Sulfex ™ Process consisting of Single Stage Neutralization followed by 2-Stage Clarification, Filtration and Sludge Dewatering	$646,000	
50% Caustic Storage and Feed System 5,000 Gal.	22,000	
Sludge Conveyor	12,000	
		$680,000
Safety and Fire Equipment		4,000
Building		
30'W.x80'L. Pre-engineered, Insulated Building		151,000
Substructures		50,000
Rigging		26,000
Piping		29,000
Electrical		78,000
Instrumentation		22,000
Insulation		3,000
Painting		6,000
TOTAL DIRECTS		**$1,049,000**
Construction Expense		
6 months duration @ $20,000/month		120,000
Premium on Overtime		5,000
Engineering		100,000
Package $600,000 @ 5%		
Other $449,000 @ 15%		
Punch List		10,000
Spare Parts		14,000
Sub Total		**$1,298,000**
Contingency and Escalation		392,000
Sub Total		**$1,690,000**
Allowance for .5 acre Land Purchase, Site Improvements, Fence		110,000
Capital Cost		**$1,800,000**
15-Year Monitoring Costs (Present worth in 1985 dollars)		NONE
Operating and Maintenance Costs (Present worth in 1985 dollars)		$2,200,000
TOTAL IMPLEMENTATION COST		**$4,000,000**

TABLE 26

CAPITAL COST HEAVY METALS REMOVAL SYSTEM 360 GPM

Process Equipment Sulfex ™ Process for 110 GPM Scaled up to 360 GPM using .6 Scale Up Factor		$1,360,000
Safety and Fire Equipment		4,000
Building 40'W.x100'L. Pre-engineered Insulated Building		250,000
Substructures		95,000
Rigging		54,000
Piping		54,000
Electrical		163,000
Instrumentation		41,000
Insulation		9,000
Painting		5,000
	TOTAL DIRECTS	**$2,035,000**
Construction Expense 6 months duration @ $20,000/month		120,000
Premium on Overtime		5,000
Engineering Package $1,360,000 @ 5% Other $ 675,000 @ 15%		169,000
Punch List		20,000
Spare Parts		27,000
	Sub Total	**$2,376,000**
Contingency and Escalation		714,000
	Sub Total	**$3,090,000**
Allowance for .5 acre Land Purchase, Site Improvements, Fence		60,000
	Capital Cost	**$3,150,000**

TABLE 27

OPERATING AND MAINTENANCE COSTS HEAVY METALS REMOVAL SYSTEM 110 GPM

Supplies		$26,000
Total Reagents Cost	$22,400	
(F. Heinze 11/6/85 memo E/R 1600E423)		
50% caustic 10 Gal/Day, 12.76#/Gal @ .0787#	3,600	
Electrical		53,000
Sulfex System Horsepower		
Assume 50HP or	37.3 KW	
Building and Site Lighting 30'x80'	10.0	
Heat Tracing	2.7	
Assume 5 Watts/LF of Pipe		
150 feet of 2"0 Pipe		
6 mo. Usage Factor		
.6 Utilization Factor		
	50.0 KW/HR @ $.12/KWH	
Heating		14,000
Assume 50 Gal/Day of Propane @ $1.50/Gal. for six months		
Maintenance		52,000
Assume 5% of Capital Cost ($1,049,000 x 5%)		
Operation and Supervision		
Included with Operating Costs of Interceptor Well System		
Disposal Costs		15,000
Sub Total		**$160,000**
Contingency		50,000
TOTAL OPERATING AND MAINTENANCE COSTS		**$210,000**

TABLE 28

OPERATING AND MAINTENANCE COSTS HEAVY METALS REMOVAL SYSTEM 360 GPM

Supplies		
Same as 110 GPM		$26,000
Electrical		140,000
Power 150 HP or	112 KW	
Lighting	15	
Heat Tracing	5	
	132 KW/HR @ $.12/KWH	
Heating		20,000
Maintenance		101,000
Assume 5% of Capital Cost ($2,035,000 x 5%)		
Operation and Supervision		
Same as 110 GPM		
Disposal Costs		
Same as 110 GPM		15,000
	Sub Total	**$302,000**
Contingency		88,000
	TOTAL OPERATING AND MAINTENANCE COSTS	**$390,000**

Allow for 6% annual inflation per annum discounted at 12% per annum for 15 years to determine total monitoring and maintenance costs (present worth in 1985 dollars).

For 110 GPM Ststem	Annual O&M Cost	$ 210,000
	15-year O&M Costs (Present worth)	$2,200,000

$$\frac{\$2,200,000}{\$210,000} = 10.5$$

Therefore for 360 GPM Annual O&M Cost $390,000

X 10.5

TOTAL OPERATING AND MAINTENANCE COSTS HEAVY METALS REMOVAL SYSTEM 360 GPM (Present worth in 1985 dollars) **$4,100,000**

TABLE 29

ALTERNATIVE S-2

A. Cover all As, Cr, Pb Waste Deposits with individual concentrations of one or more exceeding 100 PPM, and cover the East Central and the West Hide Deposit.

Cut, fill, regrade the top 12" of the existing surface to develop new contours, eliminate water pockets, promote better drainage, etc.	$ 707,000
Cover area with a 24" clay barrier constructed in 6" lifts. This clay barrier is composed of Betonite Clay mixed at a rate of four pounds per square foot with native offsite soil to achieve 10^{-7} permeability.	9,889,000
Cover clay barrier with a 6" layer of top soil and vegetate.	621,000
Relocate the South Hide Pile (include 25% swell up factor) to reshape the West Hide Pile slope (allow for one half of costs).	292,000
Cover former South Hide Area with a 6" layer of top soil and vegetate.	10,000
Reshape the slopes of the West Hide Pile using South Hide materials (allow for one half of costs).	265,000
Drain Wetlands with 60" dia. underground polyethylene pipe to stabilize hide pile slopes (allow for one half of costs).	200,000
Cover area with a 24" clay barrier constructed in 6" lifts. This clay barrier is composed of Bentonite Clay mixed at a rate of four pounds per square foot with native offsite soil to achieve 10^{-7} permeability.	630,000
Cover clay barrier with a 6" layer of top soil and vegetate.	40,000
TOTAL DIRECTS	$12,654,000
Site Overhead Costs Surveying and Test Borings Dewatering Mobilization and Demobilization Equipment and Personnel Downtime	1,504,000
Indirect Costs Site Facility Costs Stauffer Engineering & Research Personnel Outside Analytical Contractors	2,095,000
Sub-Total	$16,253,000
Contingency and Escalation	6,397,000
CAPITAL COST	**$22,650,000**

TABLE 30

ALTERNATIVE S-3

A. Cover all As, Cr, Pb Waste Deposits with individual concentrations of one or more exceeding 100 PPM, and cover the East Central and the West Hide Deposit.

Cut, fill, regrade the top 12" of the existing surface to develop new contours, eliminate water pockets, promote better drainage, etc.	$ 707,000
Cover area with a 6" clay barrier. This clay barrier is composed of Betonite Clay mixed at a rate of four pounds per square foot with native soil to achieve 10^{-7} permeability.	2,543,000
Cover clay barrier with an 18" layer of offsite fill (includes 20% compaction factor).	1,695,000
Cover fill a 6" layer of top soil and vegetate. and vegetate.	621,000
Relocate the South Hide Pile (include 25% swell up factor) to reshape the West Hide Pile slope (allow for one half of costs).	292,000
Cover former South Hide Area with a 6" layer of top soil and vegetate.	10,000
Reshape the slopes of the West Hide Pile using South Hide materials (allow for one half of costs).	265,000
Drain Wetlands with 60" dia. underground polyethylene pipe to stabilize hide pile slopes (allow for one half of costs).	200,000
Cover area with a 6" clay barrier. This clay barrier is composed of Bentonite Clay mixed at a rate of four pounds per square foot with native offsite soil to achieve 10^{-7} permeability.	162,000
Cover clay barrier with an 18" layer of offsite fill (includes 20% compaction factor).	108,000
Cover fill with a 6" layer of top soil and vegetate.	40,000
TOTAL DIRECTS	$ 6,643,000
Site Overhead Costs Surveying and Test Borings Dewatering Mobilization and Demobilization Equipment and Personnel Downtime	998,000
Indirect Costs Site Facility Costs Stauffer Engineering & Research Personnel Outside Analytical Contractors	1,146,000
Sub-Total	$ 8,787,000
Contingency and Escalation	3,513,000
CAPITAL COST	**$12,300,000**

TABLE 31

ALTERNATIVE 3-4

A. Cover all As, Cr, Pb Waste Deposits with individual concentrations of one or more exceeding 100 PPM, and cover the East Central and the West Hide Deposit.

Cut, fill, regrade the top 12" of the existing surface to develop new contours, eliminate water pockets, promote better drainage, etc.	$ 707,000
Cover area with a 24" layer of offsite fill (includes 20% compaction factor).	2,261,000
Cover fill with a 6" layer of top soil and vegetate.	621,000
Relocate the South Hide Pile (include 25% swell up factor) to reshape the West Hide Pile slope (allow for one half of costs).	292,000
Cover former South Hide Area with a 6" layer of top soil and vegetate.	10,000
Reshape the slopes of the West Hide Pile using South Hide materials (allow for one half of costs).	265,000
Drain Wetlands with 60" dia. underground polyethylene pipe to stabilize hide pile slopes (allow for one half of costs).	200,000
Cover area with a 24" layer of offsite fill (includes 20% compaction factor).	144,000
Cover fill with a 6" layer of top soil and vegetate.	40,000
TOTAL DIRECTS	$ 4,540,000
Site Overhead Costs Surveying and Test Borings Dewatering Mobilization and Demobilization Equipment and Personnel Downtime	545,000
Indirect Costs Site Facility Costs Stauffer Engineering & Research Personnel Outside Analytical Contractors	764,000
Sub-Total	$ 5,849,000
Contingency and Escalation	2,331,000
CAPITAL COST	**$ 8,180,000**

TABLE 32

ALTERNATIVE S-5

A. Cover all As, Cr, Pb Waste Deposits with individual concentrations of one or more exceeding 100 PPM, and cover the East Central and the West Hide Deposit.

Cut, fill, regrade the top 12" of the existing surface to develop new contours, eliminate water pockets, promote better drainage, etc.	$ 707,000
Cover area with a 6" layer of compacted sand. Install a 20 mil PVC membrane liner. Install a 6" layer of compacted sand over the PVC liner.	2,825,000
Cover liner and sand with a 12" layer of offsite fill (includes 20% compaction factor).	1,131,000
Cover fill with a 6" layer of top soil and vegetate.	621,000
Relocate the South Hide Pile (include 25% swell up factor) to reshape the West Hide Pile slope (allow for one half of costs).	292,000
Cover former South Hide Area with a 6" layer of top soil and vegetate.	10,000
Reshape the slopes of the West Hide Pile using South Hide materials (allow for one half of costs).	265,000
Drain Wetlands with 60" dia. underground polyethylene pipe to stabilize hide pile slopes (allow for one half of costs).	200,000
Cover area with a 6" layer of compacted sand. Install a 20 mil PVC membrane liner. Install a 6" layer of compacted sand over the PVC liner.	180,000
Cover liner and sand with a 12" layer of offsite fill (includes 20% compaction factor).	72,000
Cover fill with a 6" layer of top soil and vegetate.	40,000
TOTAL DIRECTS	$ 6,343,000
Site Overhead Costs Surveying and Test Borings Dewatering Mobilization and Demobilization Equipment and Personnel Downtime	760,000
Indirect Costs Site Facility Costs Stauffer Engineering & Research Personnel Outside Analytical Contractors	1,066,000
Sub-Total	$ 8,169,000
Contingency and Escalation	3,261,000
CAPITAL COST	**$11,430,000**

TABLE 33

ALTERNATIVE S-6

A. Cover all As, Cr, Pb Waste Deposits with individual concentrations of one or more exceeding 100 PPM, and cover the East Central and the West Hide Deposit.

Limited excavation at the PX Engineering site.

Cut, fill, regrade the top 12" of the existing surface to develop new contours, eliminate water pockets, promote better drainage, etc.	$ 706,000
Cover area with a 6" layer of top soil and vegetate.	621,000
Relocate the South Hide Pile (include 25% swell up factor) to reshape the West Hide Pile slope (allow for one half of costs).	292,000
Cover former South Hide Area with a 6" layer of top soil and vegetate.	10,000
Reshape the slopes of the West Hide Pile using South Hide materials (allow for one half of costs).	265,000
Drain Wetlands with 60" dia. underground polyethylene pipe to stabilize hide pile slopes (allow for one half of costs).	200,000
Cover area with a 6" layer of top soil and vegetate.	40,000
Excavate limited quantities of waste deposits from the PX engineering site. Transport to East/West Hide Deposit area (includes 25% swell-up factor).	38,000
Backfill excavated areas (includes 20% compaction factor).	77,000
TOTAL DIRECTS	$ 2,249,000
Site Overhead Costs Surveying and Test Borings Dewatering Mobilization and Demobilization Equipment and Personnel Downtime	270,000
Indirect Costs Site Facility Costs Stauffer Engineering & Research Personnel Outside Analytical Contractors	378,000
Sub-Total	$ 2,897,000
Contingency and Escalation	1,153,000
CAPITAL COST	**$ 4,050,000**

TABLE 34

A. Remove all As, Cr, Pb Waste Deposits with individual concentrations of one or more exceeding 100 PPM, and remove tne East Central, the West, and the South Hide Deposit.

Construct a RCRA onsite containment facility.		$ 22,838,000
Remove and replace waste deposits.		13,334,000
	TOTAL DIRECTS	$36,172,000
Site Overhead Costs Surveying and Test Borings Dewatering Mobilization and Demobilization Equipment and Personnel Downtime		4,702,000
Indirect Costs Site Facility Costs Stauffer Engineering & Research Personnel Outside Analytical Contractors		15,554,000
	Sub-Total	$56,428,000
Contingency and Escalation		22,552,000
	CAPITAL COST	**$78,980,000**

TABLE 35

ALTERNATIVE S-8

A. Remove all As, Cr, Pb Waste Deposits with individual concentrations of one or more exceeding 100 PPM; consolidate on the East Central/West Hide deposit areas; and cover the East Central and the West Hide Deposit.

Consolidation of 460,000 CY of waste deposits on the approximately 15 acres of the East Central/West Hide Deposit area will raise the elevation by 18 to 20 feet. Therefore, increase surface area by 15% to account for height.

Cut, fill, regrade the top 12" of the existing East Central Hide Pile surface to develop new contours, eliminate water pockets, promote better drainage, etc.	$ 118,000
Excavate and relocate (includes 25% swell up factor).	2,588,000
Backfill excavated areas (includes 20% compaction factor).	4,968,000
Cover area with a 6" layer of compacted sand. Install a 20 mil PVC membrane liner. Install a 6" layer of compacted sand over the PVC liner.	750,000
Cover liner and sand with a 12" layer of offsite fill (includes a 20% compaction factor).	300,000
Cover fill with a 6" layer of top soil and vegetate.	165,000
Relocate the South Hide Pile (include 25% swell up factor) to reshape the West Hide Pile slope (allow for one half of costs).	292,000
Cover former South Hide Area with a 6" layer of top soil and vegetate.	10,000
Reshape the slopes of the West Hide Pile using South Hide materials (allow for one half of costs).	265,000
Drain Wetlands with 60" dia. underground polyethylene pipe to stabilize hide pile slopes (allow for one half of costs).	200,000
Cover area with a 6" layer of compacted sand. Install a 20 mil PVC membrane liner. Install a 6" layer of compacted sand over the PVC liner.	180,000
Cover liner and sand with a 12" layer of offsite fill (includes 20% compaction factor).	72,000
Cover fill with a 6" layer of top soil and vegetate.	40,000
TOTAL DIRECTS	$ 9,948,000

TABLE 36

ALTERNATIVE S-8 cont'd

Site Overhead Costs Surveying and Test Borings Dewatering Mobilization and Demobilization Equipment and Personnel Downtime		1,194,000
Indirect Costs Site Facility Costs Stauffer Engineering & Research Personnel Outside Analytical Contractors		1,671,000
	Sub-Total	$12,813,000
Contingency and Escalation		5,127,000
	CAPITAL COST	**$17,940,000**

TABLE 36 cont'd

A. Remove all As, Cr, Pb Waste Deposits with individual concentrations of one or more exceeding 100 PPM; consolidate on the East Central/West Hide deposit areas; and cover the East Central and the West Hide Deposit.

Consolidation of 460,000 CY of waste deposits on the approximately 15 acres of the East Central/West Hide Deposit area will raise the elevation by 18 to 20 feet. Therefore, increase surface area by 15% to account for height.

Cut, fill, regrade the top 12" of the existing East Central Hide Pile surface to develop new contours, eliminate water pockets, promote better drainage, etc.	$ 118,000
Excavate and relocate (includes 25% swell up factor).	2,588,000
Cover area with a 6" layer of compacted sand. Install a 20 mil PVC membrane liner. Install a 6" layer of compacted sand over the PVC liner.	750,000
Cover liner and sand with a 12" layer of offsite fill (includes a 20% compaction factor).	300,000
Cover fill with a 6" layer of top soil and vegetate.	165,000
Relocate the South Hide Pile (include 25% swell up factor) to reshape the West Hide Pile slope (allow for one half of costs).	292,000
Cover former South Hide Area with a 6" layer of top soil and vegetate.	10,000
Reshape the slopes of the West Hide Pile using South Hide materials (allow for one half of costs).	265,000
Drain Wetlands with 60" dia. underground polyethylene pipe to stabilize hide pile slopes (allow for one half of costs).	200,000
Cover area with a 6" layer of compacted sand. Install a 20 mil PVC membrane liner. Install a 6" layer of compacted sand over the PVC liner.	180,000

Cover liner and sand with a 12" layer of offsite fill (includes 20% compaction factor).		72,000
Cover fill with a 6" layer of top soil and vegetate.		40,000
	TOTAL DIRECTS	$ 4,980,000
Site Overhead Costs Surveying and Test Borings Dewatering Mobilization and Demobilization Equipment and Personnel Downtime		598,000
Indirect Costs Site Facility Costs Stauffer Engineering & Research Personnel Outside Analytical Contractors		837,000
	Sub-Total	$ 6,415,000
Contingency and Escalation		2,565,000
	CAPITAL COST	**$ 8,980,000**

TABLE 37 cont'd

ALTERNATIVE S-10

A. Fence areas of waste deposits, deed restrictions. Limited excavation at PX Engineering site. Cover the East Central and the West Hide Deposit.

Fencing Costs, Deed Restrictions:

Area	Fencing Footage	
PX Engineering	2700 LF	
Chromium Lagoons	1500	
Janpet	-	
Wedge Area	2000	
Arsenic/Phytotoxic Area	3000	
Stafford Lot	900	
	10100 LF	$ 173,000

Janpet - Presently fenced, therefore do nothing.
Chromium Lagoons - Only the triangular shaped area between the mainline railroad right of way and west of the railroad siding is to be fenced.

Excavate limited quantities of waste deposits from the PX engineering site, transport to East/ West Hide Deposit area (includes 25% swell up factor).	38,000
Backfill excavated areas (includes 20% compaction factor).	77,000
Cut, fill, regrade the top 12" of the existing East Central Hide Pile surface to develop new contours, eliminate water pockets, promote better drainage, etc.	118,000
Cover fill with a 6" layer of top soil and vegetate.	104,000
Relocate the South Hide Pile (include 25% swell up factor) to reshape the West Hide Pile slope (allow for one half of costs).	292,000
Cover former South Hide Area with a 6" layer of top soil and vegetate.	10,000

ALTERNATIVE S-10 cont'd

Reshape the slopes of the West Hide Pile using South Hide materials (allow for one half of costs).	265,000
Drain Wetlands with 60" dia. underground polyethylene pipe to stabilize hide pile slopes (allow for one half of costs).	200,000
Cover area with a 6" layer of top soil and vegetate.	40,000
TOTAL DIRECTS	$ 1,317,000
Site Overhead Costs Surveying and Test Borings Dewatering Mobilization and Demobilization Equipment and Personnel Downtime	167,000
Indirect Costs Site Facility Costs Stauffer Engineering & Research Personnel Outside Analytical Contractors	173,000
Sub-Total	$ 1,657,000
Contingency and Escalation	663,000
CAPITAL COST	**$ 2,320,000**

TABLE 38 cont'd

ALTERNATIVE S-11

A. Cover all Waste Deposits, As greater than 300 PPM, Pb greater than 600 PPM, Cr greater than 1000 PPM, and cover the East Central and the West Hide Deposit.

Cut, fill, regrade the top 12" of the existing surface to develop new contours, eliminate water pockets, promote better drainage, etc.	$ 388,000
Cover area with a 24" layer of offsite fill (includes 20% compaction factor).	1,241,000
Cover fill with a 6" layer of top soil and vegetate.	341,000
Relocate the South Hide Pile (include 25% swell up factor) to reshape the West Hide Pile slope (allow for one half of costs).	292,000
Cover former South Hide Area with a 6" layer of top soil and vegetate.	10,000
Reshape the slopes of the West Hide Pile using South Hide materials (allow for one half of costs).	265,000
Drain Wetlands with 60" dia. underground polyethylene pipe to stabilize hide pile slopes (allow for one half of costs).	200,000
Cover area with a 24" layer of offsite fill (includes 20% compaction factor).	144,000
Cover fill with a 6" layer of top soil and vegetate.	40,000
TOTAL DIRECTS	$ 2,921,000
Site Overhead Costs Surveying and Test Borings Dewatering Mobilization and Demobilization Equipment and Personnel Downtime	350,000
Indirect Costs Site Facility Costs Stauffer Engineering & Research Personnel Outside Analytical Contractors	491,000
Sub-Total	$ 3,762,000
Contingency and Escalation	1,508,000
CAPITAL COST	**$ 5,270,000**

A. Cover all Waste Deposits, As greater than 300 PPM, Pb greater than 600 PPM, Cr greater than 1000 PPM, and cover the East Central and the West Hide Deposit. Limited excavation at the PX Engineering site.

Cut, fill, regrade the top 12" of the existing surface to develop new contours, eliminate water pockets, promote better drainage, etc.	$ 388,000
Cover fill with a 6" layer of top soil and vegetate.	341,000
Relocate the South Hide Pile (include 25% swell up factor) to reshape the West Hide Pile slope (allow for one half of costs).	292,000
Cover former South Hide Area with a 6" layer of top soil and vegetate.	10,000
Reshape the slopes of the West Hide Pile using South Hide materials (allow for one half of costs).	265,000
Drain Wetlands with 60" dia. underground polyethylene pipe to stabilize hide pile slopes (allow for one half of costs).	200,000
Cover fill with a 6" layer of top soil and vegetate.	40,000
Excavate limited quantities of waste deposits from the PX engineering site. Transport to East/West Hide Deposit area (includes 25% swell-up factor).	38,000
Backfill excavated areas (includes 20% compaction factor).	77,000
TOTAL DIRECTS	$ 1,651,000
Site Overhead Costs Surveying and Test Borings Dewatering Mobilization and Demobilization Equipment and Personnel Downtime	198,000
Indirect Costs Site Facility Costs Stauffer Engineering & Research Personnel Outside Analytical Contractors	277,000
Sub-Total	$ 2,126,000
Contingency and Escalation	854,000
CAPITAL COST	**$ 2,980,000**

TABLE 40

ALTERNATIVE S-13

A. Remove all As, Cr, Pb Waste Deposits with individual concentrations of one or more exceeding 100 PPM, and remove the East Central, the West, and the South Hide Deposit.

Excavation with offsite disposal (includes 25% swell-up factor).	$138,131,000
Backfill excavated areas with offsite fill (includes 20% compaction factor).	7,957,000
TOTAL DIRECTS	$146,088,000
Site Overhead Costs Surveying and Test Borings Dewatering Mobilization and Demobilization Equipment and Personnel Downtime	1,382,000
Indirect Costs Site Facility Costs Stauffer Engineering & Research Personnel Outside Analytical Contractors	2,302,000
Sub-Total	$149,772,000
Contingency and Escalation	59,908,000
CAPITAL COST	**$209,680,000**

Total 15-Year Monitoring Costs (Present Worth in 1985 Dollars)	None
Operating and Maintenance Costs (Present Worth in 1985 Dollars)	None

Note: Costs associates with excavation of the Janpet Site (contaminated soils) could be considerably higher because of abandoned plant equipment and ruins.

TABLE 41

MONITORING AND MAINTENANCE COSTS

Annual Inspection of Remedial Action Program

53 Acres Contaminated Soil
21 Hide Areas
74 Acres

Allow for visual inspection of .5 Hr/Acre
or 40 Hours
25 Hours Report Writing
65 Hours X $45 = $ 2,900
Travel Expenses 800
$ 3,700

ANNUAL MAINTENANCE COSTS

Mowing costs twice per year @ .50 Hrs/Ac. @ $50/Hr.
74 x .50 x 2 x $50 = $ 3,700

Revegetation costs once per year (Orig. seeding costs @ $1800/Ac., for revegetation use 15%)
74 Ac. x $1800 x .15 = $20,000

Erosion Control, Drainage Maintenance.
Allow for $100/Ac. Per Year (EPA Report)
74 Ac. x $100 = $ 7,000

Allowance for Shrink/Swell, Freeze/Thaw Repairs $ 600

Sub-Total	**$35,000**
CONTINGENCY & ESCALATION	10,000
TOTAL YEARLY COST	**$45,000**

TABLE 42

SEMI ANNUAL SAMPLING AND ANALYSIS COSTS

Purging and Pumping Wells, Collecting and Delivering Samples:

1 Day	Prep	
1	Purge, Pump	
1	Collect, Deliver	
2	Travel	
5 Days x 8 Hrs. x 2 People X $75/Hr. (ERC $36/Hr. x 25% Anal. O/H + 59% ERC O/H) =		$ 6,000 X 2 = $12,000
+ Travel Exp. @ $100/Day = 5x100x2x2		4,000
		$16,000

Analysis Costs		
15 Samples Per Trip @ $600 Ea.		$ 9,000
		X 2
		$18,000

	Sub Total	$34,000
CONTINGENCY		11,000
	TOTAL	**$45,000**

ASSUME THAT AIR SAMPLING OF HIDE PILE GAS IS DONE EITHER WHEN WATER SAMPLING IS DONE OR WHEN ANNUAL INSPECTION IS DONE.

Monitoring Maintenance	$45,000
Sampling Analysis	45,000

TOTAL YEARLY MONITORING AND MAINTENANCE COSTS **$90,000**

TABLE 43

ALTERNATIVE A-2

B. Cover East Hide Pile for odor control.

Relocate the South Hide Pile (include 25% swell up factor) to reshape the East Hide Pile Slope (allow for one half of costs).	$ 292,000
Cover former South Hide Pile area with a 6" layer of top soil and vegetate.	10,000
Reshape the slopes of the East Hide Pile using South Hide materials (allow for one half of costs).	265,000
Drain wetlands with 60" dia. underground polyethylene pipe to stabilize hide pile slopes (allow for one half of costs).	200,000
Cover area with a 6" layer of compacted sand. Install a 20 mil PVC membrane liner. Install a 6" layer of compacted sand over the PVC liner.	165,000
Cover liner and sand with a 12" layer of offsite fill (includes 20% compaction factor).	66,000
Cover fill with a 6" layer of top soil and vegetate.	36,000
TOTAL DIRECTS	$ 1,034,000
Site Overhead Costs Surveying and Test Borings Dewatering Mobilization and Demobilization Equipment and Personnel Downtime	124,000
Indirect Costs Site Facility Costs Stauffer Engineering & Research Personnel Outside Analytical Contractors	174,000
Sub-Total	$ 1,332,000
Contingency and Escalation	528,000
CAPITAL COST	**$ 1,860,000**

TABLE 44

ALTERNATIVE A-3

B. Cover East Hide Pile for Odor Control.

Relocate the South Hide Pile (include 25% swell up factor) to reshape the East Hide Pile Slope (allow for one half of costs).	$ 292,000
Cover former South Hide Pile area with a 6" layer of top soil and vegetate.	10,000
Reshape the slopes of the East Hide Pile using South Hide materials (allow for one half of costs).	265,000
Drain wetlands with 60" dia. underground polyethylene pipe to stabilize hide pile slopes (allow for one half of costs).	200,000
Cover area with a 6" layer of compacted sand. Install a 20 mil PVC membrane liner. Install a 6" layer of compacted sand over the PVC liner.	165,000
Cover liner and sand with a 12" layer of offsite fill (includes 20% compaction factor).	66,000
Cover fill with a 6" layer of top soil and vegetate.	36,000
TOTAL DIRECTS	$ 1,034,000
Site Overhead Costs Surveying and Test Borings Dewatering Mobilization and Demobilization Equipment and Personnel Downtime	124,000
Indirect Costs Site Facility Costs Stauffer Engineering & Research Personnel Outside Analytical Contractors	174,000
Sub-Total	$ 1,332,000
Contingency and Escalation	528,000
CAPITAL COST	**$ 1,860,000**

TABLE 4

C. Gas Treatment for East Hide Pile Odor Control

Install a 12" layer of gravel with 6" perforated PVC pipe for gas gathering and venting system		$ 98,000
Install Blower and Control System		50,000
Blower 0-150 Ft^3 304SS	4,000	
Foundation and Enclosure	8,000	
Piping	8,000	
Electrical	6,000	
Instrumentation	4,000	
Measurements	20,000	
Install a Carbon Adsorption System		86,000
2000 Gal 304SS Vessels	12,000	
Carbon	35,000	
Foundations, Dike	16,000	
Piping	21,000	
Electrical	2,000	
TOTAL DIRECTS		$ 234,000
Construction Expense (5 months duration @ $20,000/mo.)		100,000
Engineering (15% of Total Directs)		35,000
Sub-Total		$ 369,000
Contingency and Escalation		$ 131,000
CAPITAL COST		**$ 500,000**
CAPITAL COST FROM PREVIOUS PAGE		$ 1,860,000
TOTAL CAPITAL COST		$ 2,360,000

TABLE 45 cont'd

C. Gas Treatment for East Hide Pile Odor Control

Install a 12" layer of gravel with 6" perforated PVC pipe for gas gathering and venting system		$ 98,000
Install Blower and Control System		
Blower 0-150 Ft^3 304SS	4,000	50,000
Foundation and Enclosure	8,000	
Piping	8,000	
Electrical	6,000	
Instrumentation	4,000	
Measurements	20,000	
Construction Expense (5 months duration @ $20,000/mo.)		100,000
Engineering (15% of Total Directs)		35,000
Sub-Total		$ 248,000
Contingency and Escalation		$ 37,200

CAPITAL COSTS THERMAL OXIDATION

Process Equipment		
Incinerator 150,000 BTU/HR	$28,000	
Vent Gas Blower 20 ACFM, 304 SS	4,000	
Propane Storage Tank 3,000 Gal.	20,000	
		$ 52,000
Substructures		7,000
Superstructures		3,000
Rigging		3,000
Piping		36,000
Electrical		12,000
Instrumentation		10,000
Insulation		6,000
Painting		3,000
	TOTAL DIRECTS	$132,000

TABLE 46

ALTERNATIVE A-4 cont'd

Construction Expense			
4 months Duration @ $20,000/Month			80,000
Premium on Overtime			2,000
Engineering			17,000
Incinerator	$28,000 @ 5%		
Other	$104,000 @ 15%		
Punch List			2,000
Spare Parts			3,000
		Sub Total	$236,000
Contingency and Escalation			74,000
		Capital Cost	$310,000

TOTAL FOR PREVIOUS PAGE GAS COLLECTION SYSTEM	$ 385,000
TOTAL CAPITAL COST FOR THERMAL OXIDATION	$ 695,000
TOTAL CAPITAL COST FOR ALTERNATIVE A-4	$ 2,555,000

TABLE 46 cont'd

ALTERNATIVE A-5

B. Remove the East Hide Deposit for Odor Control.

Construct a RCRA onsite containment facility.	$ 3,906,000
Remove and replace waste deposits.	2,281,000
TOTAL DIRECTS	$ 6,187,000
Site Overhead Costs Surveying and Test Borings Dewatering Mobilization and Demobilization Equipment and Personnel Downtime	804,000
Indirect Costs Site Facility Costs Stauffer Engineering & Research Personnel Outside Analytical Contractors	2,660,000
Sub-Total	$ 9,651,000
Contingency and Escalation	3,859,000
CAPITAL COST	$13,510,000

The gas treatment costs for the RCRA landfill were scaled up from the East Hide Deposit gas treatment costs.

A scale up factor of 4 was used due to the larger quantities of gases that would be generated.

East Hide Deposit Gas Treatment	$ 500,000
Scale-up Factor	x 4
	$2,000,000

Increase operating and maintenance costs (present worth in 1985 dollars) to $400,000.

TOTAL CAPITAL COST	$ 15,510,000

Table 47

ALTERNATIVE A-6

B. Remove East Hide Pile for Odor Control.

Excavation with offsiet disposal (includes 25% swell up factor).	$ 23,625,000
Backfill excavated areas with offsite fill (includes 20% compaction factor).	1,361,000
TOTAL DIRECTS	$ 24,986,000
Site Overhead Costs Surveying and Test Borings Dewatering Mobilization and Demobilization Equipment and Personnel Downtime	$ 236,000
Indirect Costs Site Facility Costs Stauffer Engineering and Reseach Personnel Outside Analytical Contractors	$ 394,000
Sub-Total	$ 25,616,000
Contingency and Escalation	10,244,000
CAPITAL COST	$ 35,860,000

TABLE 48

OPERATING AND MAINTENANCE COSTS VENT GAS HANDLING

Supplies

Electricity		$ 5,000
Blower 5HP	3.7 KW	
Lighting and Instr. Requirements	1.0	
	4.7 KW/HR @ .12/KWH	
Maintenance		3,000
Capital Costs of Blower System is $50,000		
Assume Maintenance @ 5% ($60,000 x 5%)		
Operation and Supervision		
Included with Operating Costs of Groundwater Treatment		-
Sub Total		$ 8,000
Contingency		2,500
TOTAL OPERATING AND MAINTENANCE COSTS		$10,500

Table 49

OPERATING AND MAINTENANCE COSTS ACTIVATED CARBON SYSTEM

IVP Carbon with Na Ott Onsite Regeneration

Supplies Assume Replacement of Carbon Every Five Years 12,000# @ \$2.70/# = $\frac{\$32,400}{5}$ =	\$ 6,000
Regeneration Soak Carbon in Dilute Na Ott for 24 Hours \$600/Day for Truck Rental \$500 for 300 Gal. Na Ott \$300 for Acid 2 Men for 3 Days @ \$25/Hr	\$ 4,000
Electricity	-
Maintenance Capital Costs of Carbon Adsorption System is \$81,000 Assume Maintenance @ 5% (\$81,000 x 5%)	4,000
Operation and Supervision Included with Operating Costs of Groundwater Treatment	-
Sub Total	**\$14,000**
Contingency	4,000
TOTAL OPERATING AND MAINTENANCE COSTS	**\$18,000**

TABLE 50

OPERATING AND MAINTENANCE COSTS THERMAL OXIDATION

Supplies 1.5 Gal. of Propane per hour @ $1.90 Gal.	$20,000
Electrical Assume majority of electric costs will be with Blower System, therefore allow for minor electric costs	1,000
Maintenance Use E. Stocker 3/6/85 Flare Estimate of $132,000 Capital Assume 5% of Capital ($132,000 x 5%)	7,000
Operation and Supervision Included with operating costs of Groundwater Treatment	-
Sub Total	**$28,000**
Contingency	8,000
TOTAL OPERATING AND MAINTENANCE COSTS	**$36,000**

Table 51

Summary of Alternatives, Capital, O & M and Present Worth Costs

ALTERNATIVE	CAPITAL COST	ANNUAL O&M COST	PRESENT WORTH O&M	TOTAL PRESENT WORTH	# OF YRS	4%	7%	10%
S-1	$0	$45,000	$478,000	$478,000	15	$1,000,000	$845,000	$760,000
					30	$1,500,000	$1,100,000	$850,000
					INF	$2,250,000	$1,430,000	$900,000
S-2	$781,000	$45,000	$478,000	$1,259,000	15	$2,347,000	$1,804,000	$1,500,000
					30	$4,787,000	$3,444,000	$2,800,000
					INF	$6,641,000	$4,172,000	$2,781,000
S-3	$1,351,000	$225,000	$2,390,000	$3,741,000	15	$4,700,000	$3,500,000	$2,800,000
					30	$6,650,000	$5,150,000	$4,200,000
					INF	$9,200,000	$5,780,000	$4,400,000
S-4	$4,511,000	$45,000	$478,000	$4,989,000	15	$6,300,000	$5,200,000	$4,800,000
					30	$8,950,000	$7,250,000	$6,100,000
					INF	$12,500,000	$8,070,000	$6,200,000
S-5	$0	$45,000	$478,000	$478,000	15	$1,000,000	$845,000	$760,000
					30	$1,500,000	$1,100,000	$850,000
					INF	$2,250,000	$1,430,000	$900,000
S-6	$11,651,000	$90,000	$956,000	$12,607,000	15	$14,950,000	$13,450,000	$12,400,000
					30	$19,950,000	$16,550,000	$13,900,000
					INF	$28,750,000	$18,020,000	$13,900,000
S-7	$13,300,000	$90,000	$956,000	$14,256,000	15	$16,900,000	$15,400,000	$14,350,000
					30	$21,900,000	$18,500,000	$15,850,000
					INF	$30,700,000	$20,000,000	$15,850,000
S-8	$1,351,000	$90,000	$956,000	$2,307,000	15	$3,350,000	$2,850,000	$2,450,000
					30	$5,350,000	$4,000,000	$3,000,000
					INF	$7,200,000	$4,620,000	$3,000,000
S-9	$11,421,000	$90,000	$956,000	$12,377,000	15	$13,900,000	$12,450,000	$11,450,000
					30	$18,900,000	$15,500,000	$12,900,000
					INF	$27,700,000	$17,220,000	$12,900,000
S-10	$4,051,000	$90,000	$956,000	$5,007,000	15	$6,000,000	$5,000,000	$4,300,000
					30	$8,000,000	$6,600,000	$5,200,000
					INF	$11,500,000	$7,380,000	$5,200,000
S-11	$76,951,000	$90,000	$956,000	$77,907,000	15	$80,900,000	$79,400,000	$78,350,000
					30	$85,900,000	$82,500,000	$79,850,000
					INF	$94,700,000	$84,020,000	$79,850,000
S-12	$7,541,000	$90,000	$956,000	$8,497,000	15	$9,540,000	$8,040,000	$7,950,000
					30	$11,540,000	$9,140,000	$8,450,000
					INF	$14,350,000	$9,660,000	$8,450,000
S-13	$8,991,000	$90,000	$956,000	$9,947,000	15	$11,400,000	$9,900,000	$8,900,000
					30	$13,400,000	$10,900,000	$9,300,000
					INF	$16,200,000	$10,920,000	$9,300,000
S-14	$3,330,000	$90,000	$1,870,000	$5,200,000	15	$5,800,000	$5,450,000	$5,200,000

Table 52

Summary of Alternatives, Capital, O & M and Present Worth Costs cont'd

ALTERNATIVE	CAPITAL COST	STARTUP O&M	STARTUP PRESENT WORTH	[illegible]	# OF YRS	PRESENT WORTH 4%	7%	10%
					30	[illegible]	[illegible]	[illegible]
					INF	[illegible]	[illegible]	[illegible]
B-11	[illegible]	[illegible]	[illegible]	[illegible]	15	[illegible]	[illegible]	[illegible]
					30	[illegible]	[illegible]	[illegible]
					INF	[illegible]	[illegible]	[illegible]
B-12	[illegible]	[illegible]	[illegible]	[illegible]	15	[illegible]	[illegible]	[illegible]
					30	[illegible]	[illegible]	[illegible]
					INF	[illegible]	[illegible]	[illegible]
B-13	[illegible]	$0	[illegible]	$0	15	[illegible]	[illegible]	[illegible]
					30	[illegible]	[illegible]	[illegible]
					INF	[illegible]	[illegible]	[illegible]
A-1	$0	$0	$0	[illegible]	15	[illegible]	[illegible]	[illegible]
					30	[illegible]	[illegible]	[illegible]
					INF	[illegible]	[illegible]	[illegible]
A-2	[illegible]	$0	[illegible]	[illegible]	15	[illegible]	[illegible]	[illegible]
					30	[illegible]	[illegible]	[illegible]
					INF	[illegible]	[illegible]	[illegible]
A-3	[illegible]	[illegible]	[illegible]	[illegible]	15	[illegible]	[illegible]	[illegible]
					30	[illegible]	[illegible]	[illegible]
					INF	[illegible]	[illegible]	[illegible]
A-4	[illegible]	[illegible]	[illegible]	[illegible]	15	[illegible]	[illegible]	[illegible]
					30	[illegible]	[illegible]	[illegible]
					INF	[illegible]	[illegible]	[illegible]
A-5	[illegible]	[illegible]	[illegible]	[illegible]	15	[illegible]	[illegible]	[illegible]
					30	[illegible]	[illegible]	[illegible]
					INF	[illegible]	[illegible]	[illegible]
A-6	[illegible]	$0	[illegible]	$0	15	[illegible]	[illegible]	[illegible]
					30	[illegible]	[illegible]	[illegible]
					INF	[illegible]	[illegible]	[illegible]

TABLE 52 cont'd